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TREATMENT OF SIMPLE CHRONIC LARYNGITIS

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Simple chronic laryngitis, a common nonspecific inflammatory disease of the larynx, presents one of the most difficult problems in treatment in the entire field of laryngology. The large number of predisposing and exciting etiologic factors, a majority of which are found outside the larynx, justify Kyle's dictum that the laryngeal changes often are a "local manifestation of a systemic condition."

The belief that chronic laryngitis can be cured only by local measures applied to the larynx alone obviously is based on a lack of knowledge of the underlying pathologic changes and a failure to appreciate the importance of etiologic factors. Before considering treatment, it would seem important, therefore, to consider briefly the pathologic alterations in the laryngeal structures and to discuss causal factors.

The changes in the tissues vary, depending on the character of the lesion and the intensity and the duration of the inflammatory reaction. The changes may vary, moreover, in different persons, owing to certain tissue reactions. Although this cannot be proved conclusively, there undoubtedly is a curious tendency in some persons toward excessive proliferation of fibrous tissue. When irritation is continued, hyperemia and cellular infiltration of the mucosa and the submucosal layers are followed by organization of inflammatory exudate with an increase in connective tissue elements. Although this commonly involves the entire larynx, it usually is most marked in the structures exhibiting the greatest activity, namely the vocal cords, the ventricular bands and the interarytenoid area. With increased irritation there usually is thickening of the epithelium with generalized fibrotic hypertrophy of the soft tissues and of the musculature and changes in the circulatory and in the glandular structures. These changes may ultimately lead to greatly thickened and rounded vocal cords, hypertrophied ventricular bands and fibrosis of the muscles, with interference in normal approximation, vibration and tension of the vocal cords. Treatment to be effective, therefore, must be directed toward relieving tissue changes which interfere with normal laryngeal function, as well as toward removal or correction of the cause.

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ETIOLOGY AND TREATMENT

With the exception of abuse or excessive use of the voice and repeated attacks of acute laryngitis, the causes of chronic laryngitis are found outside the larynx. Any of the conditions capable of producing prolonged diffuse hyperemia of the larynx may be a cause of chronic laryngitis. These conditions may be roughly classified as infections, irritative conditions and systemic disorders. Under infections may be considered diseases of the upper air and food passages and of the tracheobronchial tree. The irritative conditions would include smoke, dust and gases, as well as excessive use or abuse of the larynx. Among systemic conditions would be included the effects of alcohol, defective elimination, gout, hepatic or cardiorenal disease and hypertension. More than a single factor is operative in a majority of cases. It is important to recall that in syphilis, tuberculosis and carcinoma there is chronic laryngitis, which in the earlier stages must be reckoned with diagnostically.

In treating a chronic nonspecific inflammatory disease one must treat the patient as well as the disease. Alleviation of symptoms is important. Although the effects of local treatment are temporary, they will aid in enlisting the patient's interest and assistance. Ultimate success in treatment depends on the detection and the removal or the correction of etiologic factors. The salesman who talks constantly and improperly, smokes incessantly, drinks freely of alcoholic beverages, eats at irregular times and travels at night in a Pullman sleeper is interested less in advice concerning correction of his habits than in local measures to be employed in securing relief from his laryngitis.

Before one proceeds with treatment for chronic laryngitis it is imperative that a diagnosis of chronic laryngitis be made. In many cases carcinoma of the larynx is erroneously labeled as chronic laryngitis until the disease becomes advanced. A diagnosis of chronic laryngitis should be made only after exclusion, by appropriate studies, of all conditions simulating chronic laryngitis.

The local measures to be employed in treatment depend on the severity of the symptoms and on the laryngoscopic observations. Every effort should be made to decrease the chronic congestion of the larynx. Three don'ts—don't talk; don't smoke; don't use alcohol—should be enforced. Vocal rest, preferably absolute, is an important aid; in the case of a person who uses his voice excessively it may be necessary to rest the voice for several months. Smoking is irritating to the larynx and to the tracheobronchial tree and should be interdicted, particularly if indulgence has been excessive. Smokers of cigarets often assert that inhaling aids to get rid of thick secretions, particularly in the morning. Alcohol, which normally produces hyperemia of the larynx, should be

discontinued. These measures may suffice in a case of simple laryngitis if the cause can be removed. In the cases of more obstinate involvement additional measures are necessary.

Local medication directed to the larynx may be administered by inhalation, application or instillation. A gargle does not reach the larynx. A spray or an inhalent in the hands of a patient uninstructed in its employment usually is not effective. A direct application to the vocal cords is prone to traumatize the mucosa. Instillation by the indirect method constitutes an effective means of laryngeal medication. A medicament is employed to secure a cleansing, astringent, sedative or antiseptic effect. Thick, sticky secretion may be gotten rid of by employing an alkaline solution or preferably physiologic solution of sodium chloride, either as a spray or by indirect instillation. Inhalation of compound tincture of benzoin U. S. P. or of menthol with the aid of a vaporizer is useful in relieving irritation. Instillation by mirror laryngoscopy of an oily solution, such as monoparachlorophenol (1 grain [0.06 Gm.] to the ounce of liquid petrolatum or of mentholated oil or 5 to 15 grains [0.32 to 0.97 Gm.] to the ounce of liquid petrolatum, in a dose of about 1 cc.), is useful. Oil of pine has been recommended highly. The topical application of silver nitrate, of zinc chloride or of solution of ferric chloride has been advocated. I have not found it desirable to employ these preparations.

Obviously, these measures are employed to give temporary symptomatic relief. Their use produces little change in the altered laryngeal tissues. The cause must be sought for and removed. It often is obscure and requires a comprehensive study of the patient and an inquiry into his health, habits, occupation and environment.

Abuse of the voice is a common cause of chronic laryngitis. It often is observed in those shouting or cheering; in those making prolonged use of the voice, as in speaking or singing, and in those making improper use of the voice, as in incorrect training to become singers. Frequent attacks of acute laryngitis and failure to rest the larynx until the inflammation from these attacks has subsided may be factors.

In a search for causative factors the nose and pharynx should be examined for obstruction. The upper air passages, the ears, the mouth, the teeth and the gums should be searched for a focus of infection. The faucial and the lingual tonsils often are the seat of disease and may serve as a reservoir of infection.

Remarkable improvement in obstinate chronic laryngitis has been observed after removal of diseased faucial tonsils, in the absence of other demonstrable causes. Disorders of the nasal passages, of the accessory nasal sinuses and of the pharyngeal tissues are the most important and potent factors in the causation of chronic laryngitis. This fact

is probably due to direct extension of the tissue changes or to direct infection of the larynx with infected or irritating material and consequent interference with normal nasal function.

If there are symptoms of dysphagia the esophagus should be investigated. Patients with organic stenosis of the esophagus, cardiospasm or a pharyngeal diverticulum often have overflow of secretions and food particles into the larynx, particularly while sleeping. This overflow may be responsible for chronic laryngitis and tracheitis.

Chronic laryngitis may be secondary to chronic tracheobronchitis or bronchiectasis. Every form of chronic pulmonary infection, including tuberculosis, must be excluded.

Coincident with these studies one should secure a careful history of the patient's habits, notably as regards smoking and drinking. His occupation should be inquired into with reference to exposure to dust, fumes, gases and cold, hot or dry air. Atmospheric conditions in themselves are not important factors unless changes are marked. Frequent trips from a heated to a cold atmosphere without adequate protective clothing may ultimately become an important causal factor.

In the cases of more obstinate laryngitis, particularly during advanced life, cardiac, renal and hepatic disease, gout, autointoxication and blood dyscrasias should be considered as possible factors.

In a comprehensive study one or more probable predisposing or exciting causes will be discovered. The close correlation of these causes renders it difficult, even hazardous, to express a positive opinion regarding the outcome of treatment. Correction of nasal obstruction or removal of diseased tonsils may not influence the chronic laryngitis of a public speaker. Change of occupation from a dusty to a dust-free environment may not be followed by improvement. One must evaluate the findings in a given case and be guided by experience and by the patient's insight into his problem.

A change in climatic environment may be helpful. Dry air, windy localities and cold winters should be avoided. A warm, balmy climate is preferable. Sea air may be beneficial. Continental writers have recommended a course of treatment at a spa. It is assumed that the general health of the patient will be carefully guarded.

For treatment of paresis of the tensors of the vocal cords resulting from fibrosis of the intrinsic laryngeal muscles, massage of the neck, administration of strychnine or iodides and the use of faradic current have been recommended. Caution must be exercised in the use of iodides, which ordinarily are contraindicated in a case of laryngeal inflammation.

In a case of marked hypertrophy of the vocal cords with redundancy of the mucosa, removal of small polypoid masses or stripping of the cords as practiced by Loré may be resorted to.

SUMMARY

To summarize briefly, chronic laryngitis is a nonspecific inflammatory disease, the causes of which are many and varied. Treatment consists of employment of local measures and removal of the cause. Although the effects of local treatment are temporary, such treatment is important. Etiologic factors must be sought for in the patient's habits, occupation, environment and general health. Improper use of the voice, repeated attacks of acute laryngitis and disorders of the accessory nasal sinuses, the nose and the oropharynx are the most important of these factors. The results of treatment are dependent on the finding of the cause and on its correction or removal.

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RELATION OF IRRITATION IN REGION OF PARANASAL SINUSES TO CERTAIN VASOMOTOR CHANGES

AN EXPERIMENTAL STUDY

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The problem of pain in the mastoid region, the neck, the base of the head and contiguous areas from infection in the region of the sphenopalatine ganglion has received much attention. There is no need to review the literature at the present time. Various explanations of this syndrome, called after Sluder, who first pointed it out clearly, have been offered by a number of students of the problem. In 1936 two of us,[1] on the basis of anatomic and experimental considerations, offered the hypothesis that Sluder's syndrome is due to vasomotor changes in the areas of pain brought about by reflexes induced through irritation by sinus disease of the nerves in the region of the sphenopalatine ganglion. This hypothesis is based on the assumption that reflex ischemia is produced, giving rise to local impulses of pain. These are presumably transmitted to the central nervous system by the segmental cutaneous nerves of the region involved. The hypothesis was strengthened by the fact that human patients with typical symptoms were relieved of their pain by injection of procaine hydrochloride into the skin of the mastoid region. The nervous pathways thought to be involved are the nasal and the palatine branch of the sphenopalatine ganglion, the great superficial petrosal nerve, the connections within the medulla oblongata with the reticulospinal tract and, through those, the connections with

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1. Larsell, O., and Fenton, Ralph A.: Sympathetic Innervation of the Nose, Arch. Otolaryng. **24**:687 (Dec.) 1936.

the segmental autonomic nerves in the lower cervical segments of the cord which supply the vasomotor innervation of the arteries of the regions involved in Sluder's syndrome.

It appeared feasible to test this hypothesis further on animals. While there is no adequate method of determining whether pain is produced in animals in the regions under consideration, the vasomotor effects at least could be tested.

MATERIAL AND METHODS

Nasal fibers from the maxillary nerve may be involved in this reflex arc. Allen [2] has shown experimentally that faradic stimulation of such fibers produces vasoconstriction and increased blood pressure. To simplify the present experiment as much as possible, the maxillary nerve was sectioned proximal to its connections with the sphenopalatine ganglion in all cases before stimulation of the sphenopalatine region with a faradic current was undertaken.

The further procedure consisted in determining the vasomotor effects of such stimulation after various links in the supposed nervous pathway previously mentioned had been sectioned. To this end the spinal cord was sectioned between the sixth and the seventh cervical segment in some of the animals, and the cervical part of the sympathetic trunk was sectioned in others. After each such operative procedure the region of the sphenopalatine ganglion was stimulated by faradic current, and the vasomotor effects in the ears of rabbits were noted and photographed. The ears were used because the blood vessels could easily be seen and photographed by transmitted light, especially after the hair was shaved off. The chief blood supply to the ear is from a branch of the posterior auricular artery, which supplies the mastoid region, so that vasomotor effects involving the one vessel should affect the other to some extent at least. This region in the human being receives its cutaneous innervation chiefly from the second and the third cervical nerve, with the cutaneous branch of the facial nerve supplying a small area.[3] The vasomotor innervation of the region is presumably by fibers from the superior cervical ganglion reaching the vessels named through the second and the third cervical nerve. There is every reason to believe that this innervation, both cutaneous and vasomotor, is essentially the same in the rabbit, although this has not been worked out in the same anatomic detail as it has in the human being.

Albino rabbits from 3 to 5 months old, weighing between 1.8 and 2.5 Kg., were used in the experiments. All operations were carried out under anesthesia with pentobarbital sodium with as near aseptic conditions as were possible in the laboratory.

The operations were done in successive stages. The technic of the first operation was as follows: After preparation of the operative field, an incision was made through the skin along the inferior border of the zygomatic processes of

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2. Allen, W. F.: (*a*) Formatio Reticularis and Reticulospinal Tracts: Their Visceral Functions and Possible Relationships to Tonicity and Clonic Contractions, J. Washington Acad. Sc. **2**:492, 1932; (*b*) Effect on Respiration, Blood Pressure, and Carotid Pulse of Various Inhaled and Insufflated Vapors When Stimulating One Cranial Nerve and Various Combinations of Cranial Nerves: I. Branches of the Trigeminus Affected by These Stimulants, Am. J. Physiol. **87**:319 (Dec.) 1928.

3. Fenton, R. A., and Larsell, O.: The Mechanism of Pain Transmission in Certain Types of Otalgia, Ann. Otol., Rhin. & Laryng. **37**:739 (Sept.) 1928.

the zygomatic and the maxillary bone. Attachments of orbital fascia along the upper border and of the masseter muscle along the lower border of the bone were dissected away. The zygomatic bone was removed by bone forceps. The fibers of the pterygoid muscles were separated by blunt dissection and the maxillary division of the fifth cranial nerve exposed. The internal maxillary artery, passing close to the nerve, was separated, and the nerve was sectioned as far posteriorly along the wall of the orbit as possible, so as to leave intact the sphenopalatine ganglion and its connections. The vidian nerve and the posterior nasal nerve, lying deeper than the maxillary nerve along the floor of the orbit, were not disturbed in this operation. From two to five days was allowed for recovery after this operation before the remainder of the experiments were undertaken.

TABLE 1.—*Results of Stimulation of the Nasal Mucosa on the Side of Operation, as Recorded by Photographs of the Vascularity of the Ear on the Same Side* *

Animal	Sex	Weight, Kg.	Operation Section	Time from Previous Operation	Photographic Results; Observations of Negatives of Vascular Fields After Stimulation of the Nasal Mucosa on the Operated Side
1	Male	2.16	Maxillary nerve	.....	Died
2	Male	2.22	Maxillary nerve	3 days	Constriction of vessels
3	Male	2.22	Maxillary nerve	5 days	Constriction of blood vessels
			Sympathetic trunk	1 hour	Dilation of vessels, remained so after stimulation
			Cord, complete section	6 days	No change in vascular field
4	Male	2.5	Maxillary nerve	5 days	Constriction
			Cord, hemisection	1 hour	No change
			Cord, complete section	1 hour	No change
5	Male	2.5	Maxillary nerve	5 days	Constriction
			Cord, hemisection	1 hour	No change
6	Female	2.5	Maxillary nerve	3 days	Constriction
			Cord, hemisection	1 hour	Slight constriction noted
			Cord, complete section	1 hour	Slight constriction noted
			Cervical part of sympathetic trunk	3 hours	No change
7	Male	1.81	Maxillary nerve	2 days	Constriction
			Cord, hemisection	1 hour	No constriction
			Cord, complete section	2 hours	No constriction
			Cervical part of sympathetic trunk	4 hours	No constriction

* In animal 6 section of the cervical spinal cord was made below the level of the seventh cervical vertebra, which accounts for constriction of the vessels when stimulated.

An attempt was made at first to use the transparent window devised and described by Clark and others [4] for studying the vessels in the ear of the side on which the operation was performed. This procedure was abandoned in favor of

4. (*a*) Clark, E. R.: Observations on Living Growing Lymphatics in the Tail of the Frog Larva, Anat. Rec. **3**:183, 1909. (*b*) Hou, H. C.: Behavior of Adrenal Transplants in the Transparent Chamber Inserted into the Rabbit's Ear, Proc. Soc. Exper. Biol. & Med. **26**:745 (June) 1929. (*c*) Sandison, J. C.: A New Method for the Study of Living Growing Tissues by the Introduction of a Transparent Chamber in the Rabbit's Ear, Anat. Rec. **28**:281, 1924; Transparent Chamber of the Rabbit's Ear, Giving a Complete Description of Improved Technic of Construction and Introduction, and General Account of the Growth and Behavior of Living Cells and Tissues as Seen Through the Microscope, Am. J. Anat. **41**:447 (July 15) 1928; Method for the Microscopic Study of the Growth of Transplanted Bone in the Transparent Chamber of the Rabbit's Ear, Anat. Rec. **40**:41 (Sept.) 1928.

photographing the entire vascular field with a magnification of about 2.77 to 3.7 times and observing the "gross" vascular changes from the photographic negatives and prints. The photographs were taken of the shaved ear before and after stimulation of the nasal mucosa on the same side, without change of the photographic apparatus in any way. The photographs were in serial order to include those before and after stimulation of the nasal mucosa after each operative stage.

The operative stages were as follows: section of the maxillary division of the fifth cranial nerve, with an allowance of from two to five days for recovery of the animal; hemisection of the cervical part of the spinal cord between the sixth and the seventh segment; complete section of the cervical part of the spinal cord at the same level, and in some of the animals (table 1) complete section of the cervical part of the sympathetic trunk between the middle and the inferior cervical ganglion.

The photographs taken of the vascular field of the ear after section of the maxillary nerve both before and after stimulation of the nasal mucosa were used as a standard to compare with photographs taken after the subsequent operations. An interval of approximately one hour was allowed after the operations before the stimulation and photographing.

TABLE 2.—*Percentage of Variation in Size (Diameter) of the Blood Vessels of the Ear After Stimulation of the Nasal Mucosa on the Same Side*

Animal	Nerve Section	Percentage of Variation
2	Maxillary	20-25 constriction
3	Maxillary	14-27 constriction
3	Sympathetic	34 dilatation
4	Maxillary	25 constriction
5	Maxillary	35 constriction
6	Maxillary	17 constriction
7	Maxillary	12 constriction

Stimulation of the nasal mucosa was accomplished with a copper electrode and a continuous faradic current derived from two dry cells led in turn into an induction coil. A current of medium strength was used in most instances, but a strong current was substituted after section of the cervical part of the spinal cord and of the cervical part of the sympathetic trunk.

Autopsy was performed on each animal after each series of experiments to verify the operative technic. A portion of the peripheral end of the sectioned maxillary division was removed and subsequently stained with osmic acid to observe the degeneration of the nerve fibers (fig. 1).

RESULTS

Reference to table 1 will show that uniform results were obtained in animals 2, 3, 4, 5 and 7. Animals 1 and 8 were not utilized because of faulty technic in operation and because of difficulties with anesthesia.

In all animals uniform results, namely, constriction of the vessels after stimulation of the nasal mucosa on the side of operation (figs. 2 and 3), were obtained after section of the maxillary division of the fifth cranial nerve. This indicated that there are other afferent fibers involved in the innervation of the mucosa of the nose besides those carried by the fifth cranial maxillary division and that these cause

vasoconstriction. They are carried in the posterior nasal, the great superficial petrosal and possibly the deep petrosal nerve, as suggested by two of us.[1]

The vasomotor response was abolished by section of the cervical part of the spinal cord at the level of the sixth spinal segment or by section of the cervical part of the sympathetic trunk between the middle and the inferior cervical sympathetic ganglion. Only in one animal was there failure to abolish the vasoconstriction after section of the

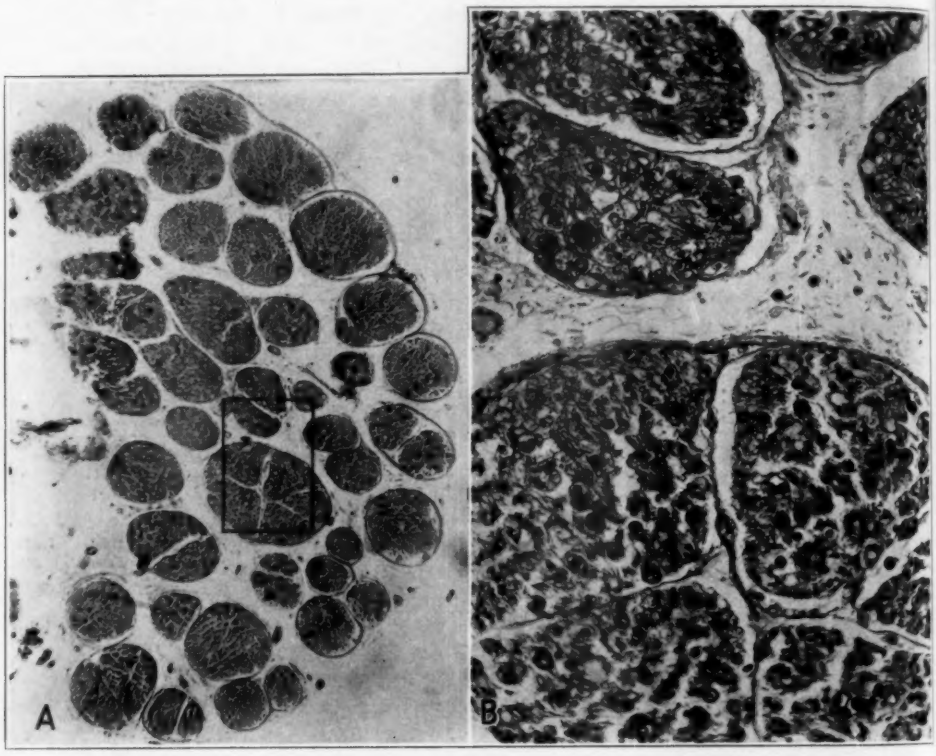

Fig. 1.—*A*, photomicrograph of a section of the maxillary nerve distal to the point at which the nerve was cut, showing degeneration of the entire nerve (osmic acid stain). *B*, photomicrograph with higher magnification of the area enclosed by the lines in figure 1 *A*, showing degenerated fibers (osmic acid stain).

cervical part of the spinal cord. Subsequent autopsy showed that in this animal the section had been made at a level at which it would fail to interrupt completely the outflow to the cervical part of the sympathetic trunk in that region, i. e., between the seventh and the eighth cervical segment.

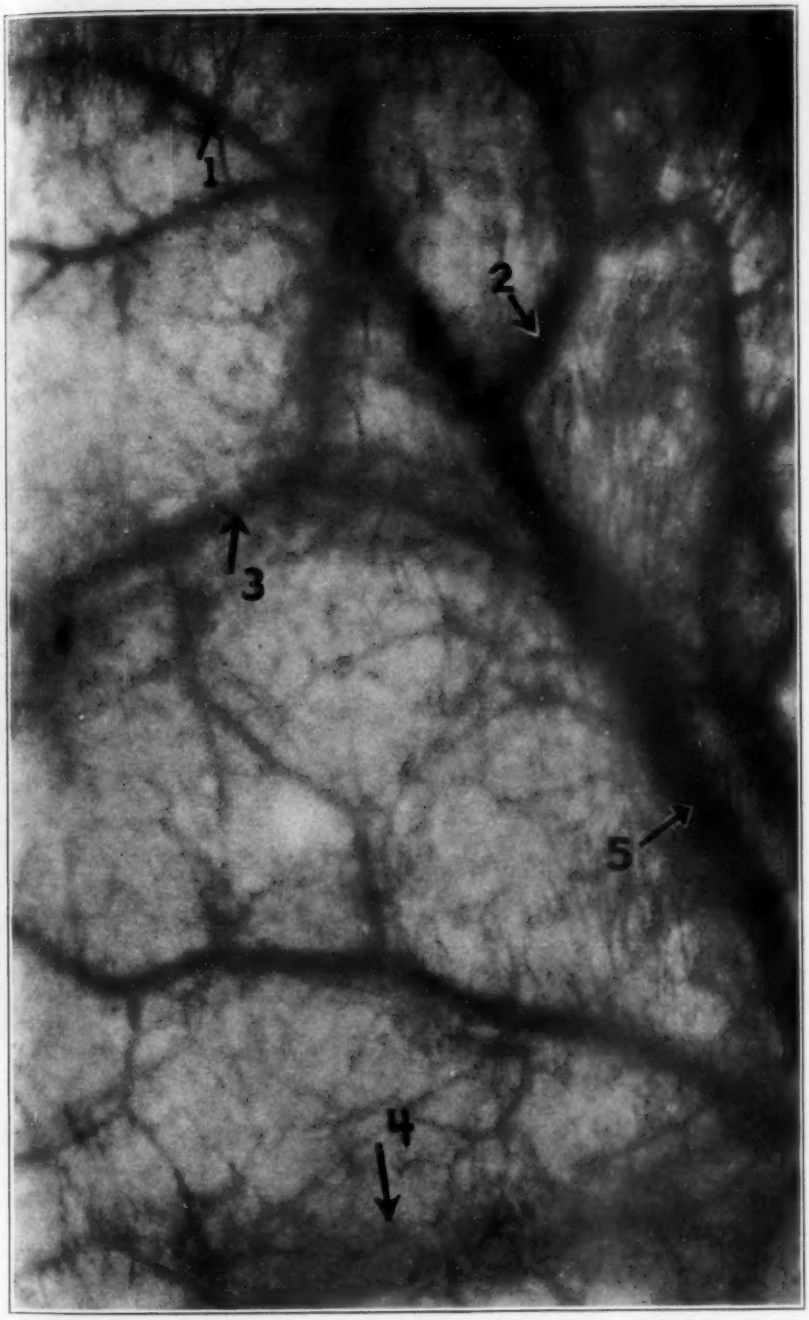

Fig. 2.—Left ear of rabbit 3, showing normal vascular field before stimulation of the region of the sphenopalatine ganglion. The left maxillary nerve had been severed proximal to the ganglion.

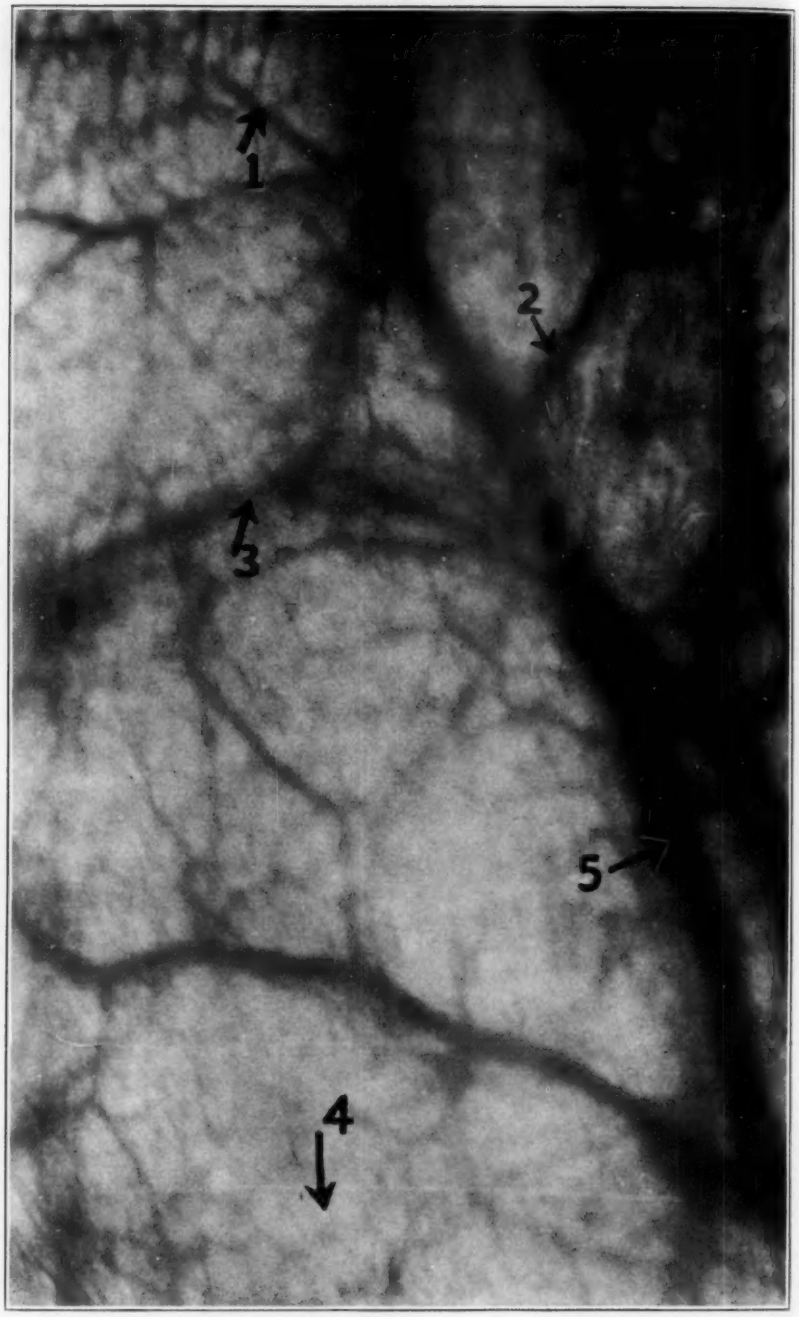

Fig. 3.—Field shown in figure 2, after faradic stimulation of the region of the sphenopalatine ganglion. There have been noticeable reduction in the diameter of the larger vessels and virtual disappearance of the capillary field. Numerals indicate regions for especial comparison, i. e., of *1* of figure 2 with *1* of figure 3, etc.

The afferent fibers in the nasal region coursing in the seventh nerve and ending in the solitary tract and its nucleus undoubtedly make synaptic connection in the reticulospinal tract. The impulses passing along this tract make connections with the preganglionic fibers of the sympathetic vasoconstrictors which arise from the lower part of the cervical and the upper part of the thoracic portion of the spinal cord, thus affecting the arteries of the ear and adjacent structures.

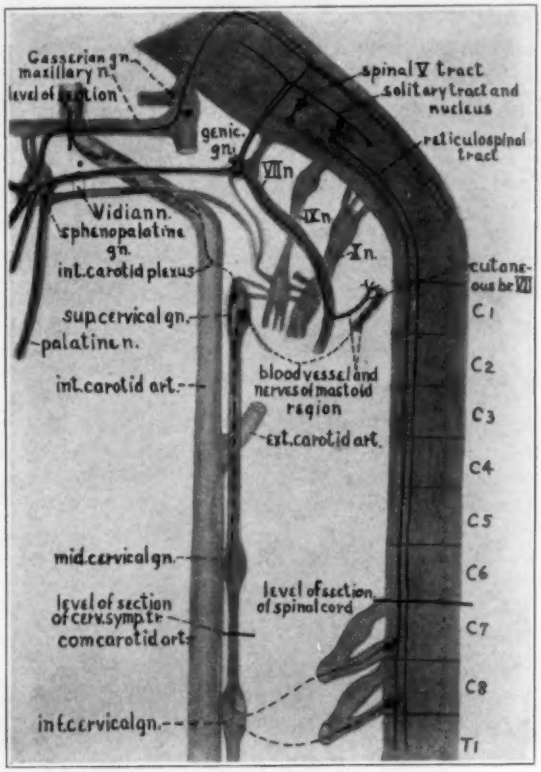

Fig. 4.—Diagram showing the levels at which the maxillary nerve, the spinal cord and the cervical part of the sympathetic trunk were sectioned, with the fiber tracts and the peripheral nerves included in the experiment.

It was possible to eliminate the impulses carried by the reticulospinal tract by section of the cervical part of the spinal cord above the sympathetic outflow. The result after section was complete lack of vasomotor response when the nasal mucosa was stimulated on the operated side. Further, after section of the cervical part of the sympathetic trunk, with the spinal cord intact, vasomotor responses failed to appear. Section of the spinal cord below the level of the autonomic

outflow to the region of the head failed to affect vasomotor responses in the ear, but they were abolished in the same animal after section of the cervical part of the sympathetic trunk.

The degree of vasomotor change under the various conditions of the experiment is indicated in table 2, which was compiled from data obtained by measuring the same blood vessel in the photographs taken before and after stimulation. The vessels were measured at the same point in their course. The variation is expressed in percentage of diameter. It will be noted that vasoconstriction to the extent of from 12 to 35 per cent below the normal diameter of the vessels resulted from stimulation of the region of the sphenopalatine ganglion when the maxillary nerve alone was sectioned. When the cervical part of the sympathetic trunk was cut in addition, there resulted dilatation of these vessels which was not affected by stimulation.

UNUSUAL COMBINATION OF OCULAR PARALYSES FOLLOWING RADICAL OPERATION ON ANTRUM

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Ocular paralysis may result occasionally from an external operation on the frontal and ethmoid sinuses or from an intranasal ethmosphenoid operation, but it is very rare to find the condition following a radical maxillary operation. The more common types of paralysis are the trochlear and the oculomotor type, from which the patient usually recovers. In the case reported here the abducens nerve and a branch of the oculomotor nerve were involved, the unusual combination of paralysis of the external rectus and inferior oblique muscles being caused. Furthermore, after a period of two and a half years there has been no recovery.

REPORT OF A CASE

M. T., a white man aged 52, a barber, when first seen by me, on March 7, 1932, was complaining of asthma and of frequent colds. He had always suffered from infection of the upper part of the respiratory tract, but asthma had not begun until Nov. 8, 1931. The family history was irrelevant except for a paternal grandfather's having had asthma.

General physical examination showed a well developed and well nourished man who was slightly dyspneic. The breath sounds were asthmatic, with a few sibilant rales at the bases of both lungs. Roentgenograms, both ordinary plates taken at 6 feet (183 cm.) and plates taken after the instillation of iodized poppy seed oil 40 per cent, showed a normal picture except for some thickening of the bronchial membrane. The blood pressure was 100 systolic and 70 diastolic. Examination of the urine gave negative results. The leukocyte count was 8,200, with 58 per cent polymorphonuclears, 34 per cent lymphocytes and 8 per cent eosinophils.

The results of special examinations were as follows: The external ocular movements were normal. The frontal and the maxillary sinuses transilluminated clearly. The nasopharyngoscope showed the left ethmoid region and the area of the left maxillary orifice to be slightly polypoid. No pus was seen. Roentgenograms revealed clouding of the left ethmoid cells and of both antrums, the left more than the right. The tonsils and the adenoids were atrophic. The third upper right molar had a pyorrheal pocket. Cutaneous tests showed moderate reactions to extracts of house dust and of ragweed.

The left antrum was irrigated, and the return flow was clear. The third upper right molar was extracted. On Aug. 2, 1932, with local anesthesia the left ethmoid cells were exenterated. On Aug. 4, a radical operation (Caldwell-Luc

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type) was performed on the left antrum with ether anesthesia. Moderately thickened, polypoid membrane was found in the upper part of the inner angle and on the orbital wall of the antrum. The patient made an uneventful recovery and was discharged from the hospital on the eighth day. He was then given injections of extracts of house dust and of ragweed and injections of vaccine. Considerable improvement was made during the next one and a half years, but he was not entirely free from asthma. During this time his right antrum was irrigated and the return flow was clear. However, it was decided to operate on the right antrum, and the operation was performed on June 25, 1934, with the patient under nitrous oxide-oxygen-ether anesthesia. A Caldwell-Luc type of operation was performed. The membrane throughout the antrum, especially in the ethmoid angle, was very polypoid. It was adherent when removed with Coakley curets and a Weille forceps. An attempt was made to enter the posterior ethmoid cells through the antrum wall, but this was not satisfactory, so no membrane was removed. There was considerable bleeding during the operation, but the patient's condition was satisfactory when it was finished. The drapes were removed, and for the first time it was noticed that his right eye protruded and rotated to the left. Neither the bulbar nor the palpebral conjunctiva was discolored. A diagnosis of orbital hematoma was made. After the patient's return to the ward, constant application of cold compresses was begun. The next day the cigaret drain was removed from the right antrum through the nostril without any bleeding. The exophthalmos and an inward rotation of the right eye were still present. The conjunctivas showed marked ecchymosis. There was no pain or fever. The patient complained only of double vision. The diplopia was verified by a test. He had complete loss of abduction of the right eye. It was thought at the time that the condition was due to pressure from the hematoma and that it would soon clear up. The exophthalmos disappeared in five or six days, but the diplopia persisted. A Wassermann test of the blood was negative. The patient was examined by Dr. R. T. Paton on the ninth day. He reported that there was complete paralysis of the external rectus and inferior oblique muscles. There was no evidence of damage to the optic or other nerves. The patient was given a glazed glass to cover his right eye and was told to report in a month. When he returned he still complained of diplopia and his right eye turned inward. At that time he was seen by Dr. J. W. White, in consultation with Dr. Paton. Dr. White concurred in the diagnosis, stating that he had never seen such a combination of ocular paralyses following a sinus operation. The patient went South for several months, and on his return, which was about six months from the date of the operation, his right eye was straight when he looked forward and he had diplopia only if he looked to the right. His case was followed for two and a half years, during which time there was not any change in the control of his muscles. A recent follow-up letter to him was not answered.

COMMENT

The unusual combination of ocular paralyses in the case reported resulted undoubtedly from radical operation on an antrum (Caldwell-Luc type). The condition was discovered while the patient was still on the operating table, and subsequent tests gave no evidence of any other cause. It was thought at first that the paralyses were due to pressure of the hematoma on the nerves or to infiltration of the muscles by blood. But since the paralyses remained permanent the nerves must have been

traumatized. It seems almost impossible that the nerves could have been injured by instrumentation without the operator's realizing that he was working in the orbit.

However, if one studies the anatomy of the orbit [1] one finds that the oculomotor nerve enters through the superior sphenoid fissure between the two heads of the external rectus muscle. The inferior root of the nerve divides into three branches, the third and largest of which passes forward between the inferior and the lateral rectus muscle to the inferior oblique muscle, entering at its posterior border. The abducens nerve also enters the orbit through the superior sphenoid fissure. It then passes between the two heads of the lateral rectus muscle to enter the medial surface of that muscle. If in the case cited a dehiscense was present in the outer portion of the roof of the antrum or if a piece of bone was removed by the biting forceps, the instrument might later have slipped into the orbit and traumatized the long branch of the inferior division of the oculomotor nerve and the abducens nerve without doing any further damage if the nerves were released without traction. The close proximity of these two nerves and the fact that no injury was done to the bulb or to any of the other nerves make this explanation well worth considering. They would also explain the hematoma, as that lesion could have resulted from injury to the inferior ophthalmic veins or to arterial branches of the lateral rectus and inferior oblique muscles. The assumption that the fibrosis resulting from the hematoma may have formed contractures around the nerves might explain the absence of improvement after two and a half years, but I do not believe that the presence of the hematoma alone could account for the immediate paralysis of the two nerves, which was so complete. It was suggested that the orbit be explored by operation and the nerves examined to see whether they were injured or simply caught in scar tissue, but the patient never returned. His failure to return also prevented the performance of roentgenographic examination of the orbit to determine whether there was calcification or a defect in its floor.

A study of textbooks on ophthalmology [2] and otolaryngology,[3] as well as of the periodical literature, reveals no mention of a case of ocular paralysis following surgical intervention in the maxillary sinus similar

1. Lewis, W. H., in Gray, H.: Anatomy of the Human Body, ed. 20, Philadelphia, Lea & Febiger, 1918, p. 835.

2. (*a*) Fuchs, H. E.: Diseases of the Eye, ed. 10, Philadelphia, J. B. Lippincott Company, 1933. (*b*) de Schweinitz, G. E.: Diseases of the Eye, ed. 10, Philadelphia, W. B. Saunders Company, 1924.

3. Thomson, St. Clair: Diseases of the Nose and Throat, ed. 3, New York, D. Appleton and Company, 1927. Jackson, Chevalier, and Coates, George M.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929.

to the one reported. De Schweinitz [2b] cited a case in which complete isolated paralysis of the internal rectus muscle appeared immediately after the removal of nasal polyps. B. B.,[4] of Guy's Hospital, reported a case in which paralysis of the inferior division of the third nerve followed removal of the anterior portion of the middle turbinate, with loss of downward and inward rotation of the eye. No explanatory discussion of the actual problems involved in the paralysis or of the ultimate outcome was given in the report of these cases.

SUMMARY

A case of paralysis of the abducens nerve and of the long branch of the inferior division of the oculomotor nerve following a Caldwell-Luc operation is reported. The paralyses were immediate and were still present after two and a half years. It is suggested that the nerves were traumatized by instrumentation through a defect in the floor of the orbit; however, fibrosis of the hematoma causing contractures around the nerves may have been a factor in the absence of later improvement. Exploratory operation on the orbit, in order to examine the nerves, was advised but was not accepted by the patient.

4. B. B.: A Case of Paralysis of Inferior Division of Third Nerve Following Removal of Anterior Portion of Mid-Turbinate, Guy's Hosp. Gaz. **28**:152 (April) 1914.

OTIC CAPSULE AND MEMBRANOUS LABYRINTH OF THE 29 MM. (CROWN-RUMP) HUMAN EMBRYO

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AND
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This report is one in a projected group dealing chiefly with the development of the cartilaginous otic capsule and the contained membranous labyrinth in human embryos. It will ultimately include a complete study of these parts in embryos of 17.5, 22.8, 29 and 40 mm.[1] length.

The importance of information concerning the cartilaginous capsule in certain other investigations of the human ear now being conducted by the department of otolaryngology and anatomy occasioned the selection of the current problem as a fundamental one. The 29 mm. (crown-rump) embryo was chosen as the first subject since, from the work of Schönemann [2] (1904), Streeter [3] (1906) and Macklin [4] (1921), it was evident that this stage represents a crucial one in the development of the capsule and the labyrinth, one in which the ground plan of the adult structures is already established.

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Contribution 253 from the Anatomical Laboratory of Northwestern University Medical School. This paper was read at the Toronto (1937) meeting of the American Association of Anatomists (abstracted, *Anat. Rec.* [supp.] **67**:34, 1937). The investigation was conducted under the auspices of the Central Bureau of Research of the American Otological Society.

1. The present paper is one of a group based chiefly on a study of the numerous series in the Harvard Embryological Collection. During the summers of 1930, 1931 and 1932 it was the privilege of Dr. Anson to study these series through the courtesy of Profs. Frederic T. Lewis and J. Lewis Bremer. The original tracings were prepared at Harvard and supplemented at Northwestern by Dr. John Martin in a reexamination of the serial sections. All reconstructions were prepared by Dr. Martin.

2. Schönemann, A.: Die Topographie des menschlichen Gehörorganes, Wiesbaden, J. F. Bergmann, 1904.

3. Streeter, G. L.: On the Development of the Membranous Labyrinth and the Acoustic and Facial Nerves in the Human Embryo, Am. J. Anat. **6**:139-166, 1906.

4. Macklin, C. C.: The Skull of a Human Fetus of 43 mm.. Greatest Length, Contrib. Embryol. **10**:59-103, 1921.

MATERIAL AND METHODS

The reconstructions described and figured in this paper were prepared from embryo 317 in the Harvard Embryological Collection. Sections 308 through 423 were used, which include the entire otic capsule, the ossicles and the adjacent portions of the brain and the chondrocranium of this embryo. This specimen, hereinafter designated "no. 317," has a crown-rump measurement of 29 mm. (about 1.87 months). The sections are cut in the frontal plane (fig. 2) at a thickness of 20 microns and are stained with a solution of sodium borate and carmine and with Lyons blue. The series is numbered 914.

The Born wax plate method of reconstruction was used. Tracings of every other section (of the right ear) were made with the aid of an Edinger projection apparatus at a magnification of either 100 or 250 diameters, according to the reconstruction desired.

Six reconstructions in all were prepared:[5] (*a*) a general reconstruction for reference (figs. 21 to 23), separable into four parts, which included the entire otic capsule, the ossicles and the adjacent portions of the brain and the chondrocranium; (*b*) one of the capsule alone, cut obliquely into three sections in order to show the labyrinthine spaces in relation to external landmarks of the capsule (figs. 1 and 3 to 10); (*c*) a less inclusive model at a higher magnification (figs. 20 and 25) showing the region of the vestibular window and the contained stapes; (*d*) one of the three ossicles with Meckel's cartilage (fig. 24), (*e*) one of the membranous labyrinth (figs. 13 and 14) and (*f*) one of the space within the otic capsule, termed hereinafter the cartilaginous labyrinth (figs. 11 and 12). Except for the basal plate and a small portion of the sphenoid cartilage, no cartilage other than that of the capsule proper and of the closely related ossicles and styloid process has been modeled. In the reconstruction of the vestibular window and stapes the outline of the window represents the extent of true cartilage, so far as can be determined; however, in some of the sections it is difficult to judge exactly where to set the limits of the formed cartilage, so gradually does this tissue merge into precartilage and perichondrium.

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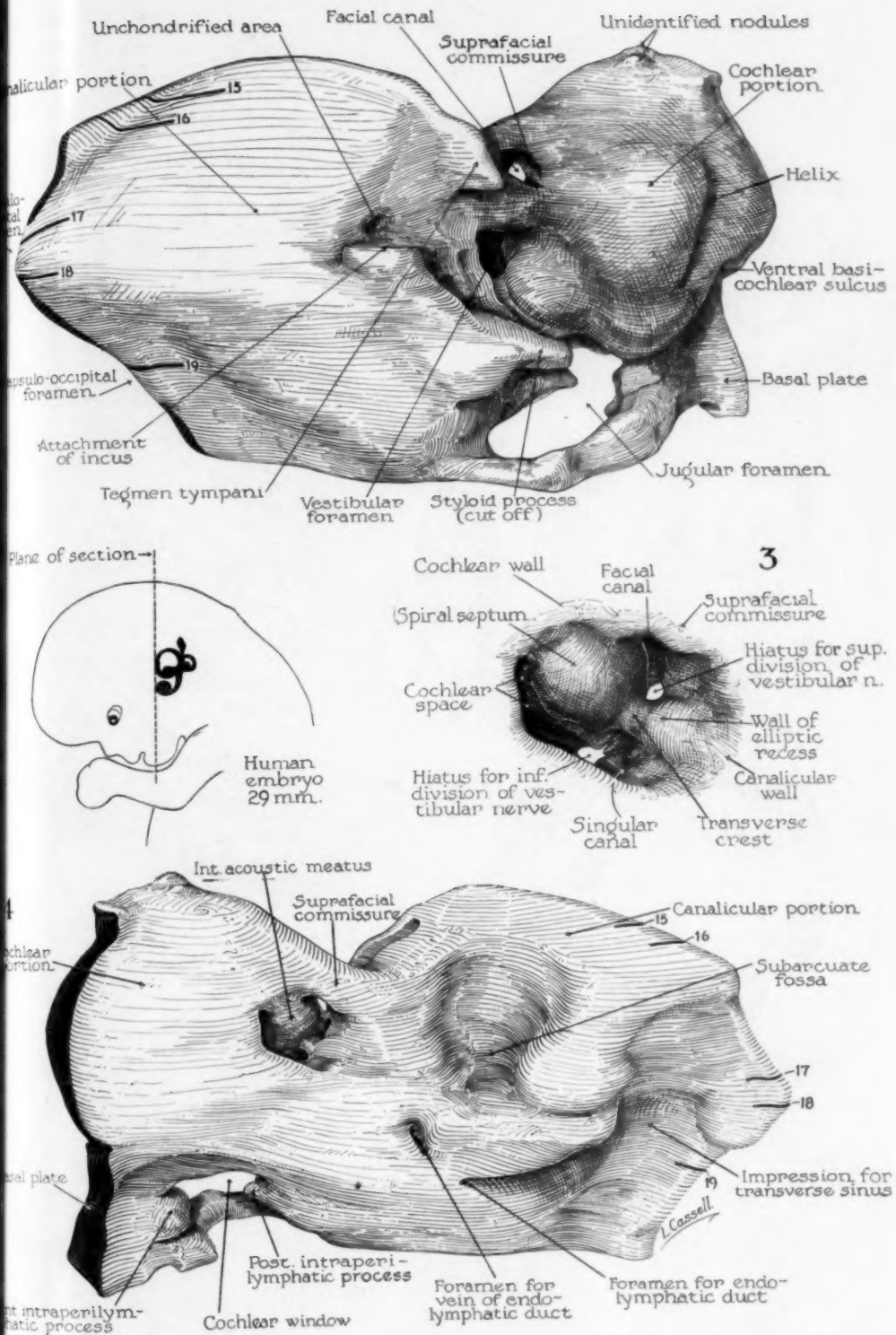
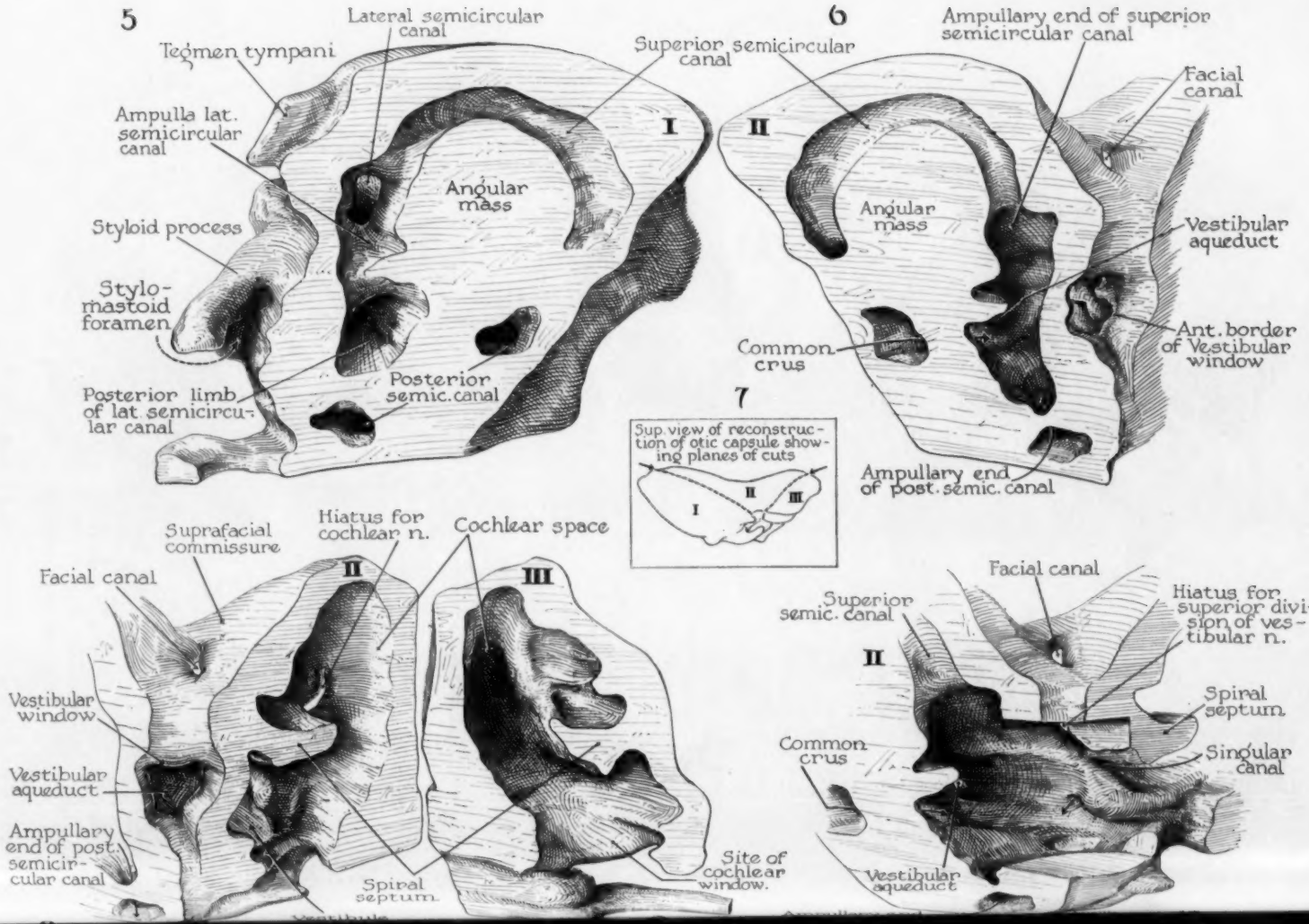
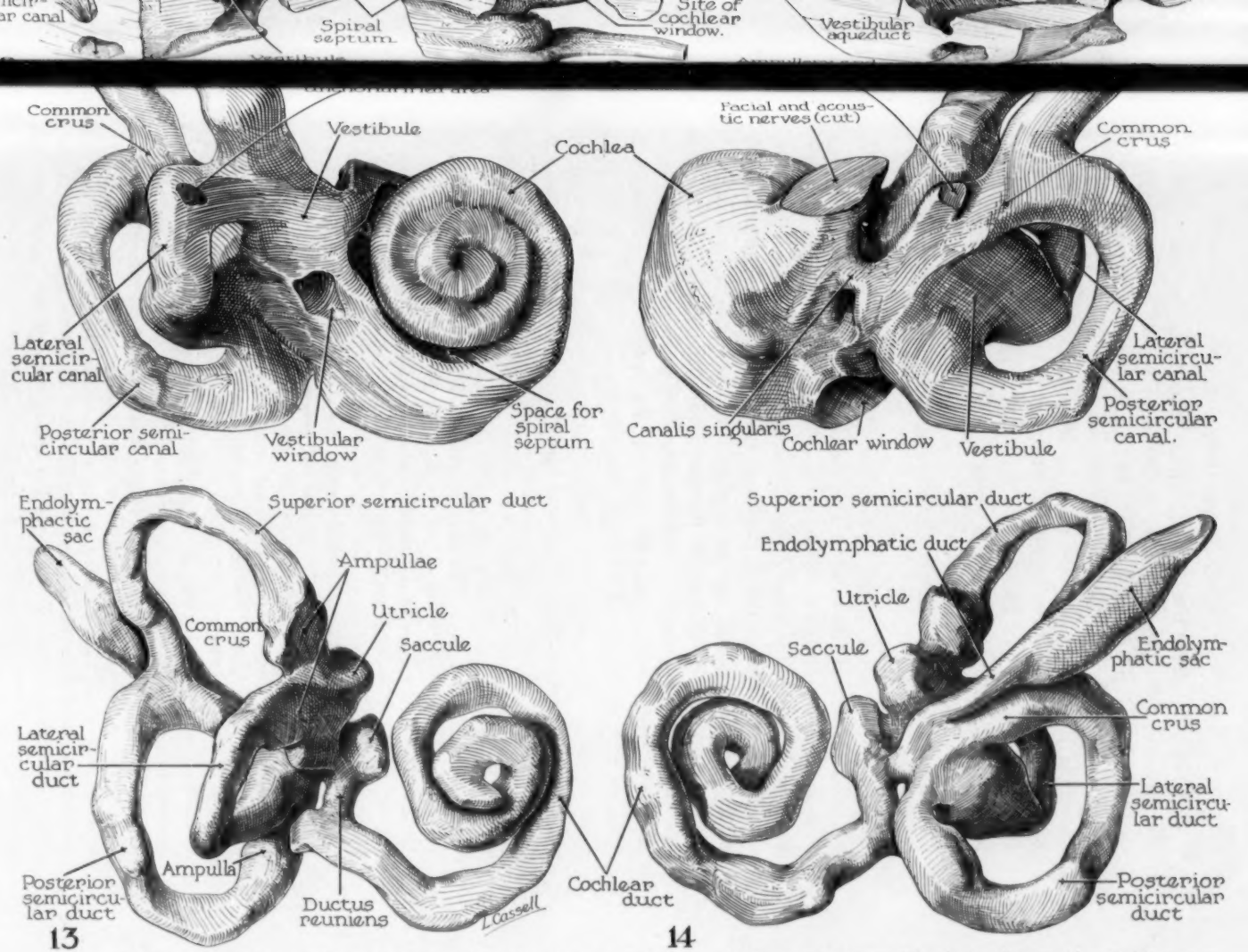
5. The reconstructions of the cartilaginous otic capsule (figs. 1, 4, 5 to 10 and 21 to 23) and of the space enclosed by the cartilaginous (figs. 11 and 12) and the membranous (figs. 13 and 14) labyrinth and the drawings were prepared at a magnification of 100 diameters and reduced to a magnification of 30 diameters in reproduction; figure 3, of the floor of the internal acoustic meatus, was drawn twice natural size and is reproduced at a magnification of 60 diameters. The photographs of the reconstruction of the capsule (figs. 21 and 23) were taken at one-third the original size and then reduced one fifth in reproduction. The portions of the microscopic fields shown in figures 15 to 19 were prepared by the Edinger projection apparatus at a magnification of 100 diameters and reduced to one-sixth that magnification in reproduction; they represent, in more detailed form, selected tracings from the full lot of fifty-eight tracings from which the reconstructions were fabricated. The reconstruction of the stapes (figs. 20 and 25) was made at an increased magnification, namely, 250 diameters; it was drawn full size and reduced about half in reproduction; in figure 25 the reconstruction was reduced two-thirds in photography and reproduced at that size. The reconstruction of the ossicles and Meckel's cartilage (fig. 24) was prepared at a magnification of 100 diameters. The photomicrograph in figure 26 was taken at a magnification of 120 diameters and reproduced without reduction. The outline of the head of the embryo (fig. 2) was adapted from the drawing in the files of the Harvard Embryological Collection.



Figs. 1-4.—Figures 1 and 4 are lateral and medial views, respectively, of the cartilaginous otic capsule (× 30). Figure 3 shows the internal acoustic meatus (× 60). Figure 2, embryo 317 (H. E. C.), showing plane of section. The lines at the left of figure 1 and at the right of figure 4 indicate the levels of the sections in figures 15 to 19 and are correspondingly numbered.


5
Lateral semicircular canal
Tegmen tympani
Superior semicircular canal
Ampulla lat. semicircular canal
I
Angular mass
Styloid process
Stylo-mastoid foramen
Posterior limb of lat semicircular canal
Posterior semic. canal
6
Ampullary end of superior semicircular canal
Facial canal
II
Angular mass
Vestibular aqueduct
Common crus
Ant. border of Vestibular window
Ampullary end of post. semic. canal
7
Sup. view of reconstruction of otic capsule showing planes of cuts
I
II
III
Suprafacial commissure
Hiatus for cochlear n.
Cochlear space
Facial canal
II
III
Vestibular window
Vestibular aqueduct
Ampullary end of post. semicircular canal
Spiral septum
Site of cochlear window.
Facial canal
Superior semic. canal
Hiatus for superior division of vestibular n.
II
Spiral septum
Common crus
Singular canal
Vestibular aqueduct



Figs. 11-14.—Figures 11 and 12 are lateral and medial views, respectively, of the cartilaginous labyrinth; figures 13 and 14, corresponding views of the membranous labyrinth (× 30). The distal projection of the endolymphatic sac is omitted (compare fig. 19).

OBSERVATIONS

The otic capsule at the 29 mm. stage is made up of two main divisions, the canalicular and the cochlear, the latter of which is considerably the smaller (figs. 1, 4 and 21 to 23). They are joined by a bridge of cartilage termed the suprafacial commissure, as well as by all the cartilage (unnamed) lying between the internal acoustic meatus and the jugular foramen medially and the facial foramen and the cochlear window laterally (figs. 1, 4 and 6). The capsule in no. 317 is placed in about the same position in relation to the basal plate as obtains in the adult temporal bone (fig. 2), and this is likewise the case in Macklin's [6] Ia. This permanent position is reached, according to Kernan,[7] between the 20 and the 28 mm. stage.[8]

The lateral aspect of the cartilaginous basal plate closely follows the rounded contour of the anterior and the medial side of the cochlear portion, forming with it the deep ventral basicochlear sulcus (figs. 1 and 15). Posteriorly, where the basal plate is thin, it is continued laterally to enter into the formation of the hypoglossal canal and the jugular foramen, while anteriorly, where it is more than twice as thick, it fuses with the posterior portion of the body of the sphenoid cartilage. The latter structure shows at this stage a rudimentary alar process, from the dorsal margin of which there passes the alicochlear process; this process, in the form of a short bridge of cartilage, extends dorsally and caudally to the most anterolateral aspect of the cochlear capsule, where with the capsule, the alar process and the basal plate it forms the closed carotid canal.[9]

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6. Macklin, C. C.: The Skull of a Human Fetus of 40 mm., Am. J. Anat. **16**:317-426, 1914.

7. Kernan, J. D., Jr.: The Chondrocranium of a 20 mm. Human Embryo, J. Morphol. **27**:605-646, 1916.

8. The general features of the cartilaginous otic capsule in this 29 mm. embryo can be compared advantageously with those in the two embryos described by Macklin (1914, 1921), which measured 40 mm. (crown-rump, specimen "Ia"), and 43 mm. (greatest length, specimen no. 886), and with those of Kernan's (1916) 20 mm. specimen (no. 325). To supplement our discussion in the text the outstanding points in the comparisons of those several specimens have been tabulated. The value of the comparison is somewhat vitiated by Kernan's failure to record whether his measurement was of crown-rump or of other length, but we have assumed it was the former.

9. In Kernan's no. 325 the alicochlear process (of the temporal wing of the sphenoid cartilage) comes in contact with the wall of the cochlear capsule, but does not actually unite with it, while in no. 317 this canal is closed, the connection between the cochlear capsule and the alicochlear process being complete though narrow. In no. 325, as in our no. 317, there was no evidence of the supracochlear cartilage described by Macklin in his 40 mm. specimen, Ia. In Ia "there is no connection with the processus alaris of the temporal region through the commissura ali-

(Footnote continued on next page)

The cochlear portion of the capsule is a modified sphere. The medial wall becomes flattened and then concave posteriorly, where it joins the canalicular portion. On this aspect is situated the internal acoustic meatus (figs. 3 and 4). The mergence of the cochlear cartilage with the basal plate is so complete that the line of separation between the two cartilages is not identifiable microscopically (fig. 15). From front to back on the lateral aspect of the cochlear portion the following important landmarks are encountered: the suprafacial commissure,[10] the facial canal, the vestibular window, the promontory, the lateral margin of the cochlear window and the jugular foramen (figs. 1 and 21 to 23). This side of the cochlear capsule is convex and is marked by a shallow sulcus in the form of a helix, which corresponds to the path of the spiral septum internally.[11] Just below the vestibular end of this sulcus, which is its deepest part, is a slight bulge in the capsular wall termed the promontory, overlying the beginning of the first turn of the cochlea. Above the space of the jugular canal and somewhat laterally lies the cochlear window (figs. 1, 9 and 12).

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cochlearis, such as Jacoby showed in the 30 mm. stage of homo and Voit figured in his model of the skull of lepus, but there is what I regard as a rudiment of this, viz., the cartilago supracochlearis" (Macklin,[6] p. 352, figs. 1 and 3). "This (the supracochlear cartilage) is a small rounded mass of cartilage, situated upon the cranial pole of the pars cochlearis. . . . It is quite free from cartilaginous union with the underlying cochlea, but the two are more closely approximated posteriorly than anteriorly, where the intervening connective tissue is thicker. . . . It is difficult to say what may be the significance of this cartilage. . . . I am inclined to regard it as a rudiment of the commissure (or trabecula) alicochlearis which Jacoby describes."

A review of nos. 325, 317 and 886 in the light of this information concerning the older 40 mm. (crown-rump) and 80 mm. stages certainly sustains Macklin's interpretation of these commissures and cartilaginous nodules. In no. 325 the commissures are obviously growing toward the capsule; in no. 317 and no 886 they are present and intimately attached; in Ia only the supracochlear cartilages are present, with the alar process and the cochlear portion of the capsule close together; in the 80 mm. (Hertwig) stage neither commissure nor cartilaginous remnants are persistent. Anteriorly, the cochlear capsule of no. 317 ends in a widely rounded oval, on which are found two small eminences (fig. 1). Neither of these is mentioned by Macklin (1914, 1921), Kernan (1916) or R. J. Terry (The Primordial Cranium of the Cat, J. Morphol. **29**:281-434, 1917), and we have been unable to assign any significance to their presence in our embryo.

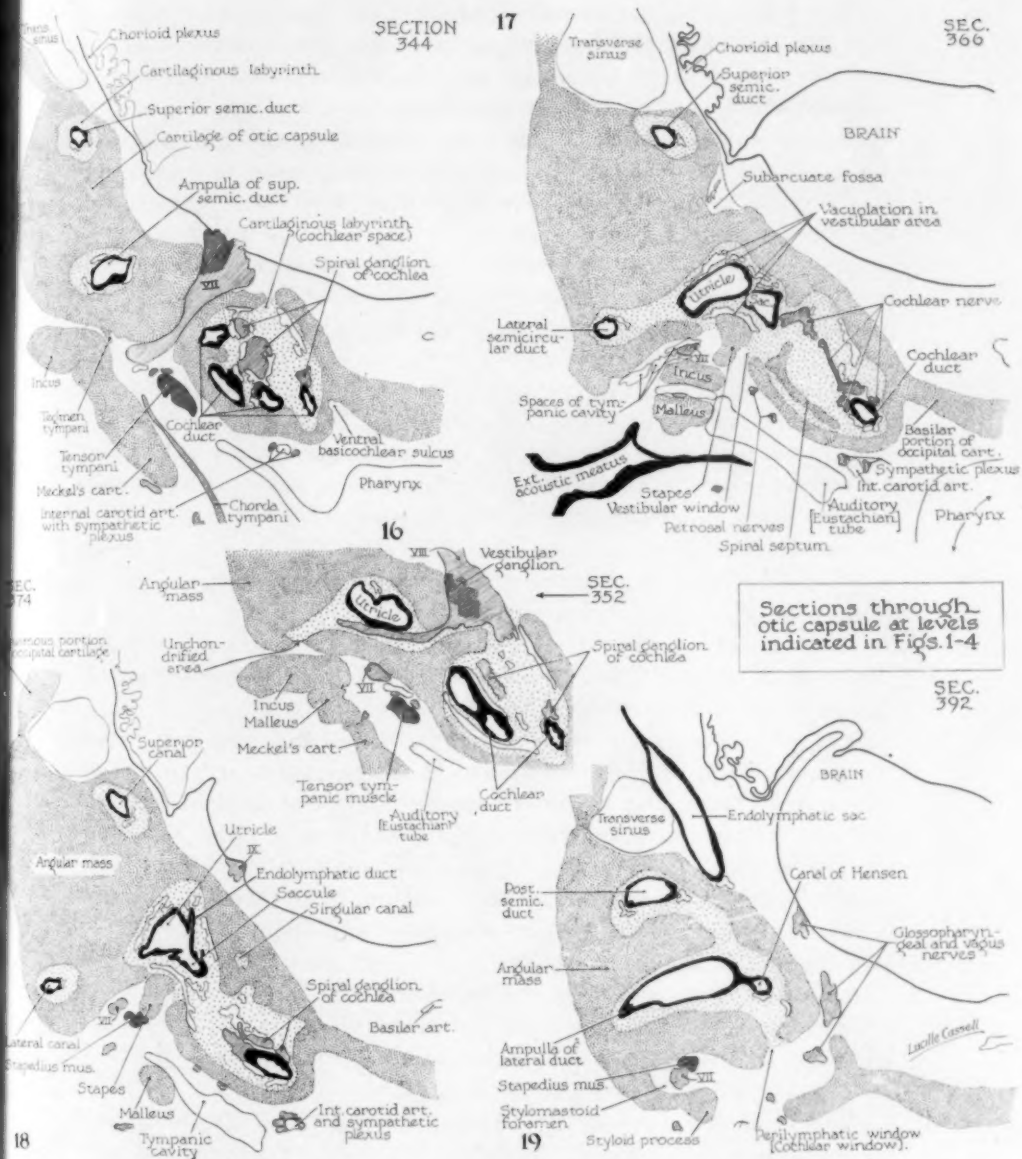
10. In no. 325 the suprafacial commissure "is far from forming a complete bridge," there being only a small projection of cartilage from the canalicular portion of the capsule at the site of the future "mesial suprafacial commissure."

11. The helix on the external surface of the cochlear portion corresponding to the spiral septum internally is a little longer in no. 317 than it is in no. 886. This is expected from a comparison of the membranous labyrinths of the two embryos; the cochlear duct of no. 317 makes slightly over two complete turns (of the ultimate two and three-quarters), while in no. 886 it makes only one and three-quarters turns.

The canalicular portion of the otic capsule is piriform and at least twice the size of the cochlear portion. Its medial surface is less plane than the corresponding surface of the cochlear wall, being broken by the apertures of the internal acoustic meatus, the subarcuate fossa, the endolymphatic foramen and the prominences which correspond to the superior and the posterior semicircular canal. The caudalmost portion of the medial wall shows a concavity just behind the endolymphatic foramen, which lodges the transverse sinus (fig. 4), and two foramina, the anterior capsuloparietal foramen and the smaller, posterior capsulo-occipital foramen (figs. 1 and 23). The canalicular capsule has a smooth rounded contour anteriorly, where it houses the superior semicircular canal, while the most anterior and lateral part is marked by a spur of cartilage, the tegmen tympani, which already shows a tendency to cover the developing ossicles (figs. 1, 5, 15 and 22). Owing to the fact that the tegmen is rapidly growing and made up at its advancing tip of various gradations of young cartilage, its extent as reconstructed is somewhat arbitrary. The parotic crest, a small, low prominence of cartilage lying between the attachment of the short leg of the incus and the styloid process, is present in the 29 mm. specimen, somewhat obscured by the ossicles as they overlie that region. Below the crest is a shallow groove which is destined to become the site of the stylomastoid foramen (figs. 5 and 19).

In order that the relation of the labyrinthine spaces to the otic capsule and its more familiar landmarks might be shown, a reconstruction was made of the capsule alone, without the adjacent portions of the brain stem, ossicles, styloid process and basilar portion of the occipital cartilage. An oblique section through both the canalicular and the cochlear portion, dividing the model into three unequal parts (fig. 7) furnishes a view of the labyrinth from the lateral wall of the capsule and preserves intact the internal acoustic meatus, the subarcuate fossa and the endolymphatic foramen (figs. 5, 6, 8, 9 and 10).

The posterior section of the capsule when viewed from a medial position shows on the cut surface almost the full arch of the superior semicircular canal, as well as a cross section of the lateral and the posterior canals (fig. 5). Below the arch of the superior canal and above the sectioned posterior canal lies a solid pyramidal mass of cartilage, with its base at the lateral wall of the capsule and its apex in the general area of the subarcuate fossa. This is the angular mass, the size and the shape of which impress the observer with the solidarity of the supporting tissues of the definitive canals (figs. 5, 6 and 18). In the absence of the incus an unchondrified area on the lateral capsular wall, related internally to the lateral semicircular canal, may be well seen (figs. 1, 11 and 16). This same area, between the body of the incus and the anterior limb of



Figs. 15-19.—Sections through the otic capsule at the levels indicated in figures 1 and 4 (× 16½).

the lateral semicircular canal, is present and of about the same size in Macklin's no. 886.

The corresponding cut surface on the middle section of the reconstruction lays open the communication of the three canals with the vestibule, which is at this stage an irregular chamber with several hiatuses which have assumed a permanent position (figs. 6 and 10). Wide spaces lead from it into each canal; posteriorly one orifice conducts the endolymphatic duct and its accompanying blood vessel to the exterior of the capsule; superiorily, above the transverse crest, is situated the opening for the superior division of the vestibular nerve through the superior fossa of the internal acoustic meatus; anteriorly, the vestibule communicates with the meatus under the transverse crest by way of the inferior fossa; the saccular portion of the vestibule opens anteriorly and inferiorly into the cochlear space and the cochlear window (fig. 8); the vestibular window (figs. 6 and 8) communicates with the vestibule at its lateralmost point; the canalis singularis lies on the anteromedial wall of the vestibule (fig. 10). In summary, then, it may be said that the vestibule contains eleven distinct orifices leading either to the exterior of the capsule or to other parts of the labyrinth.

In general, the ultimate form of the future bony labyrinth is less well represented in the cochlear than in the canalicular portion of the embryonic otic capsule. The plane of section separating the anterior from the middle portion of the reconstruction divides the anterior two thirds of the cochlear space from the posterior third and shows advantageously the primordial spiral septum, which at this stage is of young, rapidly growing cartilage (figs. 8, 9 and 17). The septum arises from the posterior and the superior portion of the cochlear space, so that its base extends posteriorly to form the floor of the facial canal and posteromedially to transect the internal acoustic meatus as it forms the transverse crest (fig. 3). Sweeping forward on the anterolateral wall of the cochlear portion, the septum completes slightly more than one turn and terminates indefinitely on the lateral cochlear wall (figs. 8 and 9). The septum here is apparently higher and longer than it is in no. 886. The cochlear space, swinging in a broad crescent from its origin at the internal acoustic meatus, follows the turns of the septum and ends blindly in a broad space in the region of the future capsule. Below, it communicates broadly with the cochlear window (fig. 9).

The vestibular window (figs. 1, 6, 8, 11 and 17) is deeply set in a considerable depression in the lateral capsular wall. Its actual histologic limits are difficult to determine, because the developing annular ligament blends almost imperceptibly with the cartilage of the fenestral margins. The plunger-like stapes is inserted deeply into the window (figs. 17, 18, 20 and 25).

The cochlear window ("fenestra perilymphatica," Macklin) is separated from the vestibular window by the sulcus of the spiral septum and the promontory (figs. 1 and 9). It is shallow and roughly circular, and it looks principally downward and backward. Its borders are formed by a raised shell of cartilage, most prominent posteriorly, where an actual spur of cartilage has already formed the "posterior intraperilymphatic process" (Macklin), and anteromedially, where the capsule joins the basal plate in a low ridge of cartilage, the "anterior intraperilymphatic process" (fig. 4).[12]

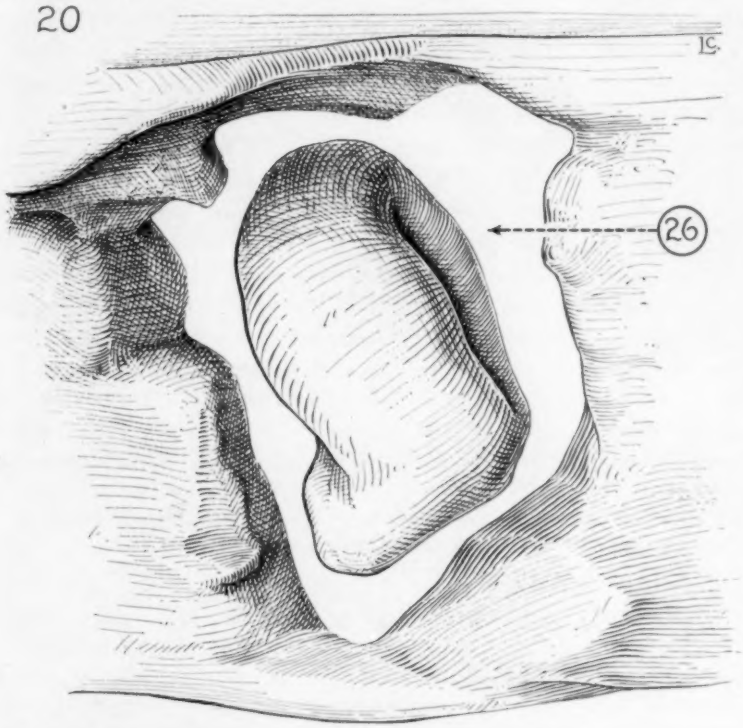


Fig. 20.—Medial (vestibular) view of the stapes and the vestibular window; a drawing of the reconstruction photographed in figure 25 (× 120).

12. The cochlear window is markedly less well developed in no. 325 than it is in either no. 317 or no. 886, and the intraperilymphatic processes in no. 325 are only beginning to form, whereas they are prominent structures in these other two embryos, being particularly well developed in no. 886. Neither in our specimen nor in those of Kernan and of Macklin have the posterior and the anterior intraperilymphatic processes fused, so that in all cases the cochlear aqueduct, differentiated from the cochlear window by their ultimate fusion, is unfounded. Macklin mentioned, however, that in Hertwig's 80 mm. fetus the cochlear window is closed off on the left side and almost so on the right.

The jugular foramen is a relatively large opening between the uncompleted boundaries of the cochlear window anteriorly (from which it is not yet separated because of the nonunion of the anterior and the posterior intraperilymphatic processes), the wall of the capsule, and the junction of the basal plate and the squama of the occipital cartilage posteriorly (figs. 1 and 19). Through it course the jugular vein from the transverse sinus, and the glossopharyngeal, the vagus and the spinal accessory nerves, lodged in loose cellular tissue.

On the medial wall of the canalicular capsule there is evident a large depression, the subarcuate fossa (figs. 4 and 17). The loose, vascular connective tissue which fills it will be an important factor in the ossification of the capsule.[13] Antero-inferior to this fossa the vestibular aqueduct traverses the medial wall of the capsule and contains the endolymphatic duct, together with some small blood vessels, all embedded in mesenchymal tissue (figs. 4, 10 and 12). Although the vessels and the duct leave the vestibular space through a common aqueduct, they have separate external exits (fig. 14).[14] The vein emerges into the subarachnoid space through a foramen somewhat anterior to the endolymphatic foramen; the foramen for the vein, small and round, is separated from the endolymphatic foramen by a thin layer of cartilage, the intervening area at first seeming to be wider than it actually is, owing to the fact that a rim of cartilage overhangs the endolymphatic foramen. Both foramina lie in the prominence of the common crus. The endolymphatic foramen is remarkably capacious in comparison with

13. In Ia the fossa is deep, filled with loose connective tissue and leveled over by the dura. Kernan stated that in no. 325 the subarcuate fossa is well marked, though figure 1 of his models would indicate that it is really shallow, as compared to the fossa of the older no. 317. T. H. Bast (Development of the Otic Capsule: I. Resorption of the Cartilage in the Canal Portion of the Otic Capsule in Human Fetuses and Its Relation to the Growth of the Semicircular Canals, Arch. Otolaryng. **16**:19-38 [July] 1932) stated that ossification of the canalicular portion of the otic capsule is preceded by a process of resorption and replacement of cartilage by vascular connective tissue; this process begins at the subarcuate fossa. In the group of series in which Bast studied the growth of the canalicular portion of the capsule, the youngest embryo was 25 mm. (crown-rump); yet an increased amount of vascular perichondrium was already dipping into the subarcuate fossa (Bast, T. H.: Development of the Otic Capsule: II. The Origin, Development and Significance of the Fissula Ante Fenestram and Its Relation to Otosclerotic Foci, Arch. Otolaryng. **18**:1-20 [July] 1933, fig. 1).

14. G. E. Shambaugh (in Jackson, C., and Coates, G. M.: The Nose, Throat, and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1929, p. 396) stated, "There is a decided variation in different individuals regarding the distribution of the veins from the vestibule between the outlet at the aqueductus cochleae and the outlet along the aqueductus vestibuli." Certainly the condition found in no. 317 is different from that reported by either Kernan or Macklin.

the caliber of the duct which it transmits. Its lateral wall is thin, owing to the encroachment of the posterior semicircular duct. The foramen is shelved anteriorly and superiorly on its aspect by a thin, protecting sheath of young cartilage; thus its cranial or external orifice looks as much posteriorly as it does medially (fig. 4). The endolymphatic foramen in no. 325 is relatively much larger than it is in the 29 mm. embryo.

The internal acoustic meatus, situated on the cerebral aspect of the capsule, is deeply set (figs. 3, 4 and 16). It is roughly oval, with the long axis of the oval coinciding with that of the entire capsule. The meatus opens mainly into the canalicular end of the cochlear portion of the capsule. The upper border is formed by the inferior edge of the suprafacial commissure, and the lower, by the medial cochlear wall and by the junction of the latter with the canalicular portion. These two borders of the meatus are fairly sharp and well marked, while the anterior and the posterior borders are lower and hence of indefinite extent. Spanning the meatus anteroposteriorly is a cartilaginous bar, the transverse crest, which is a combination of the upper end of the spiral septum and the anterior portion of the wall of the elliptic recess; in no. 886 it is similar. This crest divides the meatus into a superior and an inferior fossa. The superior fossa is further divided into two passageways by the floor of the facial canal; the upper space is the medial end of the facial canal, and the lower, the hiatus for the passage of the superior division of the vestibular nerve, which terminates in the macula of the utricle and the ampullae of the lateral and the superior semicircular canal. The inferior fossa is, likewise, roughly separated into two portions by the posterior end of the spiral septum and a spur which reaches back from the septum toward the upper wall of the canalis singularis. Antero-inferiorly is situated the large crescent-shaped opening into the cochlear space; posteriorly and superiorly, deep in the fossa, lies the hiatus for the passage of the inferior division of the vestibular nerve as it courses toward the saccular macula. Below this hiatus and leading from the floor of the inferior fossa into the vestibular space is the short, comparatively wide singular canal, which conveys the posterior division of the vestibular nerve to the ampulla of the posterior canal. These are, it will be recalled, the five main spatial divisions of the meatus in the adult bone.

There is no collection of tissue associated with either the left or the right otic capsule of no. 317 which can with certainty be said to be the primordium of the mastoid eminence. But at the level in the series where the cartilage should appear (on the posterolateral surface of the canalicular portion, behind and slightly below the attachment of the styloid process) there is actually present a mass which stains more deeply than the surrounding mesenchyme; it is attached to the capsule merely

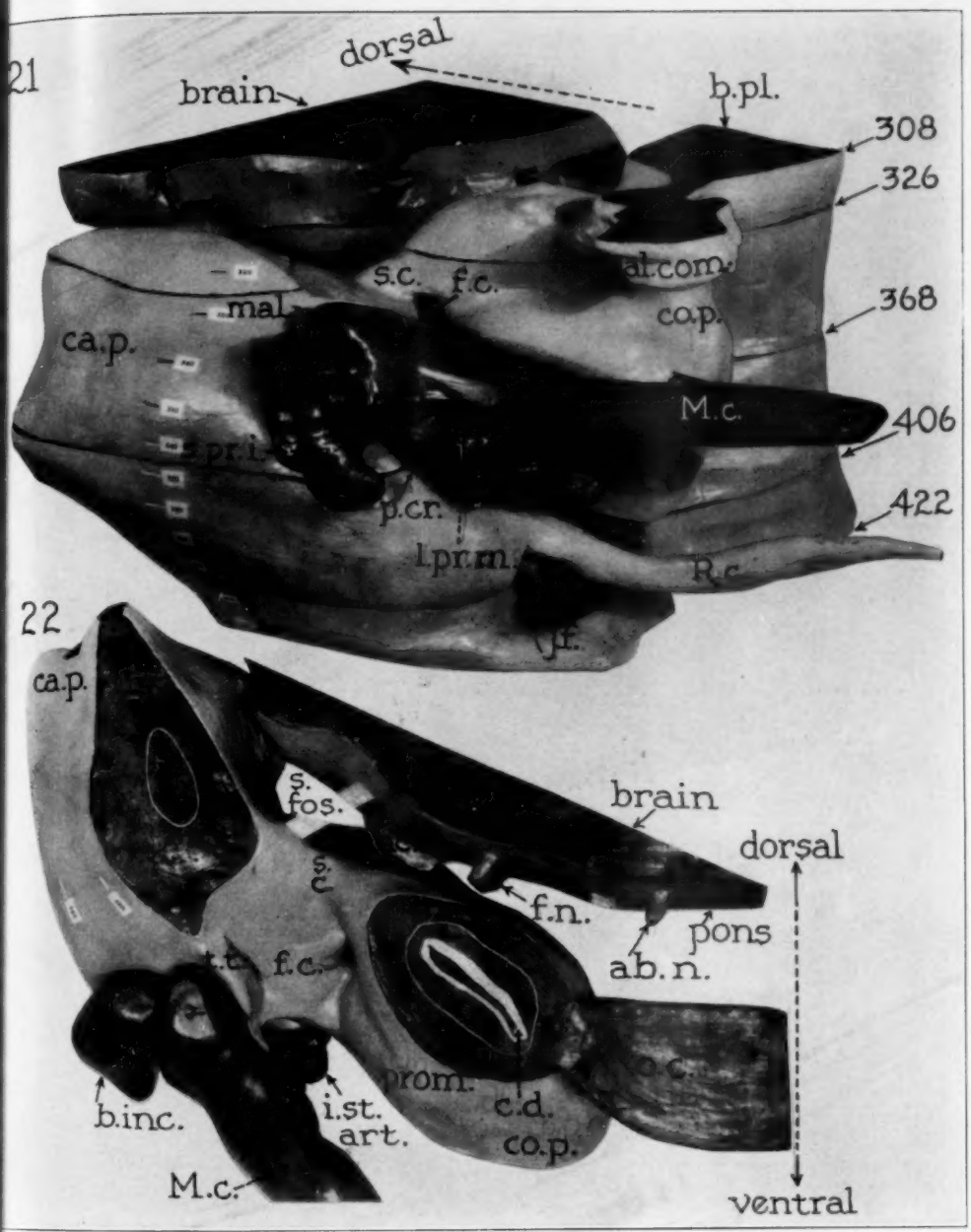
by a thick layer of perichondrium-like tissue, within which lies a core of precartilage, not yet continuous through true cartilage.[15]

The styloid process is a long, spur-shaped projection of cartilage, which at the 29 mm. stage is continuous with the capsule (figs. 1, 19, 21 and 23). It forms part of the lateral border of the future stylomastoid foramen (figs. 5 and 19). Its thick base curves sharply medialward to lie almost directly posterior to the manubrium; then, narrowing gradually, it curves posterolaterally; still tapering, it terminates in a pointed tip.

Meckel's cartilage is considerably larger than any one of the ossicles. It runs without interruption from the anterior aspect of the malleus into the mandible as the core of the latter cartilage (figs. 15, 16 and 21 to 24); curving first slightly laterally then medially, it courses downward and forward toward the jaw. The relative prominence of the cartilage in the embryo is particularly striking when it is recalled that in the adult it has lost all association with the ossicles. The goniale, a membrane bone which arises in the perichondrium of the malleus on its dorsomedial side, was not identified in the specimen studied; it becomes the anterior (folian) process of the adult, often little more than a slender bony spur.

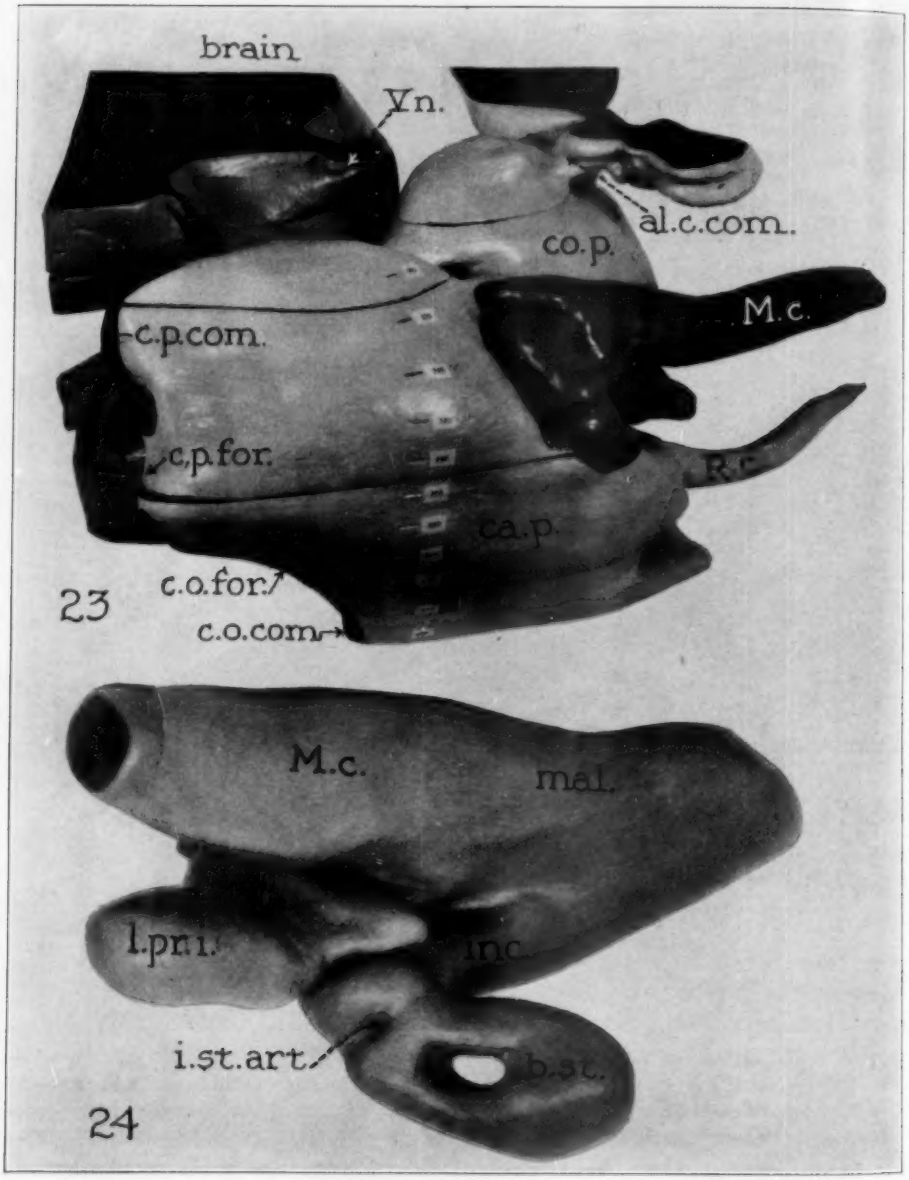
There is no indication at the 29 mm. stage of separation of the head of the malleus from Meckel's cartilage; nor is there in no. 886. The manubrium of the malleus is an elongate structure lying inferior to Meckel's cartilage and arising from the neck of the ossicle at an angle of approximately 60 degrees with the cartilage of Meckel. Near its point of origin, on the medial side, is a distinct tubercle of cartilage, which is the site of insertion of the tendon of the tensor tympani muscle. Almost directly opposite this tubercle on the lateral side of the malleus, near the junction of the manubrium with the neck is a larger, more rounded eminence of cartilage, which will become the lateral process. The neck is short and flattened mediolaterally; from the region of the lateral process it curves slightly upward to the head, with the concavity directly upward and inward. The limits of the head are indefinite, since it is no more than a rounded prominence, separated from the incus only by a shallow notch of the superior aspect. In sections, however, the line of separation is evident, although at the incudomalleolar junction no articular cavity as yet exists between the two ossicles (figs. 15 and 16).

15. Kernan stated that it is a well developed spur of cartilage, intimately connected to the cartilaginous capsule by a thick sheet of perichondrium; Macklin, that it is a distinct cartilaginous nodule separated from the capsule by perichondrium in his 43 mm. fetus. In Ia the mastoid cartilage is distinctly formed, being composed of young cartilage directly continuous with the substance of the capsule dorsally but separated from it medially by perichondrium, representing a developmental advance over both no. 886 and no. 317. Since it arises independently, such variation is expected.



Figs. 21-22.—Photographs of reconstruction (× 27). Figure 21 is an anterolateral view of the otic capsule and related structures, especially the ossicles, Meckel's cartilage (continuous with the malleus), the styloid process and the brain. The section of the upper surface of each portion of the reconstruction is indicated by a number. The broken line marks the midline of the embryonic head. Figure 22 shows the superior aspect of the second piece of the reconstruction seen in figure 21, especially the relations of the ossicles and of Meckel's cartilage to the otic capsule.

In figures 21 to 26 the abbreviations used are as follows: *ab.n.*, abducent nerve; *ac.n.*, acoustic nerve; *al.com.*, alar commissure; *al.c.com.*, alicochlear commissure; *b.inc.*, body of incus; *b.pl.*, basal plate; *b.st.*, base of stapes; *ca.p.*, canalicular portion; *c.d.*, cochlear duct; *c.o.com.*, capsulo-occipital commissure; *c.o.for.*, capsulo-occipital foramen; *co.p.*, cochlear portion; *c.p.com.*, capsuloparietal commissure; *c.p.for.*, capsuloparietal foramen; *cr.st.*, crus of stapes; *f.c.*, facial canal; *f.n.*, facial nerve; *inc.*, incus; *i.st.art.*, incudostapedial articulation (future); *j.f.*, jugular foramen; *l.pr.i.*, long process of incus; *l.pr.m.*, lateral process of malleus; *mal.*, malleus; *M.c.*, Meckel's cartilage; *mes.*, mesenchyma; *o.c.*, occipital cartilage; *p.cr.*, parotic crest; *per.sp.*, periotic space; *prom.*, promontory; *R.c.*, Reichert's cartilage; *sac.*, saccule; *s.c.*, suprafacial commissure; *s.pr.i.*, short process of incus; *s.s.c.*, superior semicircular canal; *s.fos.*, subarcuate fossa; *st.*, stapes; *t.t.*, tegmen tympani; *utr.*, utricle; *v.*, vestibule (future); *Vn.*, fifth nerve; *v.w.*, vestibular window.

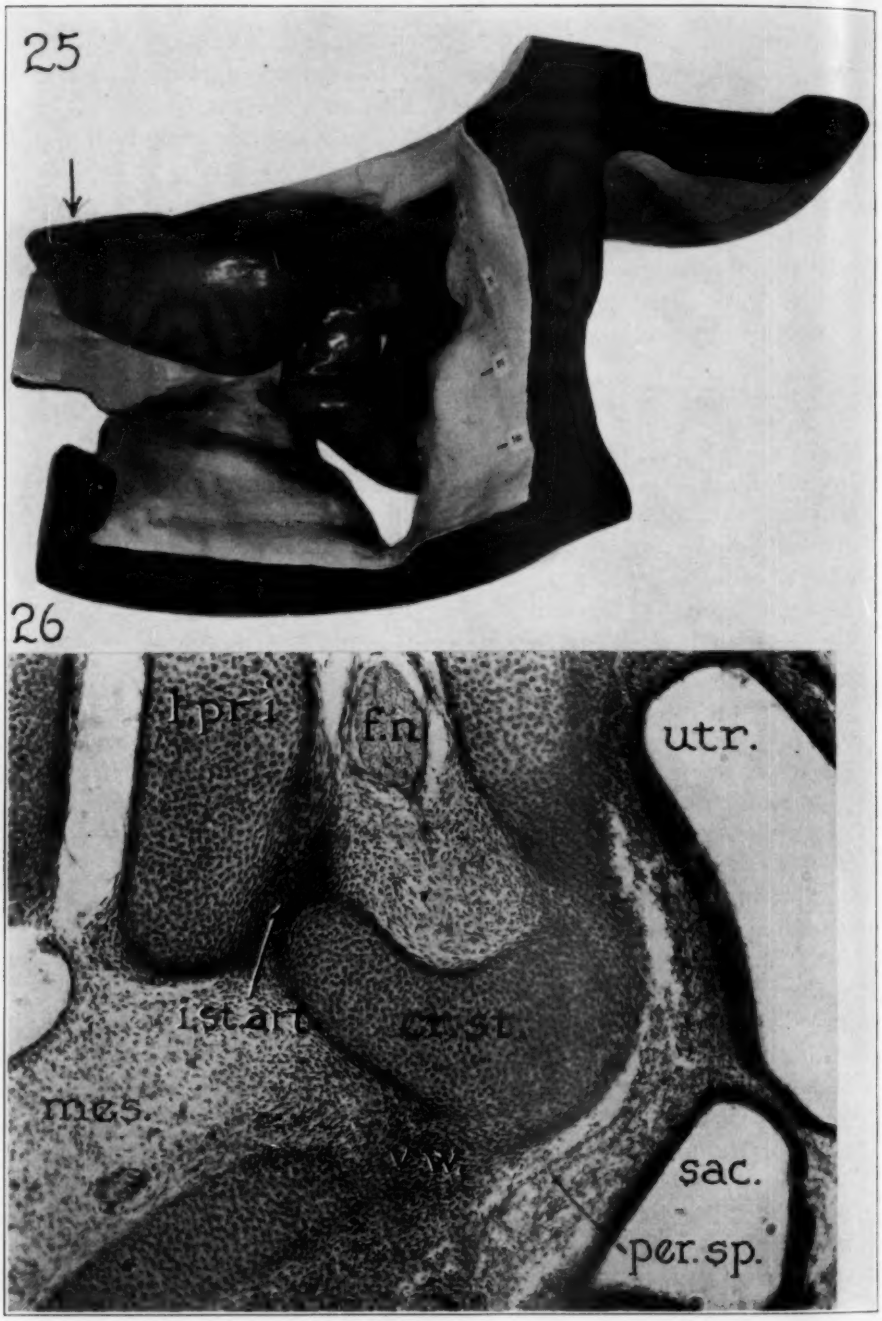


Figs. 23-24.—Figure 23 is a photograph of the reconstruction, continued (× 27), showing a superior and more lateral view of the otic capsule and related structures. Figure 24 shows an anteromedial view (capsular aspect) of the cartilaginous ossicles (× 53). The arrow marks the line of the incudostapedial junction. The prominence on the proximal end of the malleus serves for insertion of the tensor tympani muscle.

The general form of the incus in no. 317 more clearly approximates that of the adult bone than does that of either of the other ossicles. The incus is made up of a short and a long leg, with an intervening body. It is separated from the head of the malleus only by a notch on its superior surface, not by a joint. The short leg is conical and extends backward and downward into the posterior portion of the epitympanic recess, where it is yet attached at the site of the future incudal fossa, which is slightly below and a little lateral to the anterior limb of the lateral semicircular canal. The tissue connecting the incus with the capsule is a sheet of perichondrium, structurally similar to that which surrounds the contiguous surfaces to the stapes and the long leg of the incus. The long leg points inward and downward and joins the stapes at an angle of 90 degrees. Here again there is no articular cavity, the lenticular process of the incus and the head of the stapes each merging into a common mass of young cartilage. The line from the tip of the short leg to the tip of the long leg is markedly concave—more concave, in fact, than half a sphere and far more so, incidentally, than it is in the adult bone (approximately 100 degrees). This is due to the fact that in the embryo the short leg is relatively longer than it is in the adult bone and meets the capsule in an almost straight anteroposterior line.

Of special interest are the stapes and the relation of this ossicle to the outline of the oval window (figs. 17, 18 and 24 to 26). The stapes is essentially annular; it is lodged in loose cellular tissue, and through it pass small blood vessels, although the stapedial artery has not yet made its appearance. The stapes lies with its anterior leg at a level considerably below its posterior leg, already assuming the adult position. The opening in the ring is small, while the crura bounding it are thick. The incudal side of the ring is its narrowest portion and presents a conelike narrowing suggesting a primordial head; on this site is found a small notch, where the future articulation with the incus will be situated. The stapedial extremity of the long process of the incus is a smooth, bluntly ending cartilage, connected to the stapes at an angle of approximately 90 degrees by a thick layer of perichondrium which envelops both ossicles; there is as yet no articular cavity (fig. 24, reconstructed to include the perichondrium, and fig. 25, without the perichondrium). The intrafenestral portion of the ring is distinctly thicker and heavier than is the lateral portion; although the future base displays some flattening, its extremities are but vaguely indicated by two low elevations of cartilage on the vestibular aspect.

The window at this stage is not oval; it is a roughly quadrilateral opening, no two sides of which are of equal length; it rests in the deepest part of a generous concavity in the lateral capsular wall (fig. 20). The posterior half of the window follows closely the contour of the stapes,



Figs. 25-26.—Figure 25 is an anterolateral (tympanic) view of the reconstruction of the stapes and associated structure (× 83), showing the stapedial end of the long crus of the incus (arrow) and the stapes deeply placed in the vestibular window. The level of the section shown in figure 26 is indicated by a leader correspondingly numbered. Figure 26 is a photomicrograph of the stapes and associated structures through the superior crus (× 120).

but in the anterior half this regularity is lost, except in that portion which is bordered by the promontory. A wide space separates the posterior half of the ring from the canalicular side of the window; the anterior half and the cochlear side of the window would be similarly separated were it not for the presence of a spur of cartilage which extends from the edge of the foramen almost to the stapes (in Macklin's no. 886, actually thereto). Above and below this spur occur shallow recesses. Thus, although the stapes is deeply inserted into the vestibular window, it falls considerably short of filling that orifice; the intervening tissue is precartilage, perichondrium and light-staining cells destined to form the stapedial ligament (fig. 26). Similar conditions are present in Macklin's no. 886.[16]

The membranous labyrinth, as seen in the reconstructions, presents many features characteristic of the adult condition. The cochlear duct, made up of two and a quarter turns, is considerably flatter (that is, less conical in cross section) than it is in the adult ear; yet a transverse section of the duct already shows its general triangular shape, with the apex of the triangle pointing toward the modiolus (fig. 15). The semicircular ducts, with their ampullae, and the common crus approximate closely the adult form. The saccule is connected with the cochlea by the canalis reuniens (Hensen's canal) and with the endolymphatic duct by a shorter limb; although the endolymphatic duct is already marked off from the utricle by a deep fold (fig. 18), their communication is relatively much wider than it is in the adult. The utricle is distinctly divided into two chambers; the superior or anterior part receives the ampullary ends of the superior and the lateral semicircular duct and the utricular duct; the inferior or posterior part, which is pyramidal, receives at its lateral or apical end the crus simplex of the lateral semicircular duct and on its medial or basal aspect the ampullary end of the posterior duct, the endolymphatic duct, the posterior portion of the saccule and the common crus (figs. 13 and 14).

The endolymphatic duct is a long, slender tube arising from the region of the utricle (figs. 14 and 18); it passes posterosuperiorly, toward the cerebral side of the capsule, crossing the common crus

16. A study is in progress on the development and the histologic structure of the stapes in man, including representative stages from the 17.5 mm. embryo to the old adult. Apparently the stapes grows rapidly, once it has become a separate structure; thus we have found that the length of the stapes, from head to base, has increased by one and three-fourths times between the 29 and the 40 mm. (crown-rump) stage. Much of the vestibular aspect of the base remains cartilaginous throughout life. Likewise, in a large series of bones, including all ages from the embryo of 135 mm. to a 70 year old adult, the margins of the vestibular window are invariably cartilaginous. We discussed this briefly in papers presented before the Philadelphia meeting of the American Association of Anatomists (abstracted, Anat. Rec. [supp.] **58**:47 and 79 [March] 1934).

obliquely as it does so; reaching the exterior of the capsule, it widens into the fusiform endolymphatic sac (figs. 13, 14 and 19). The longitudinal plications, which are a striking feature of the duct in the adult, are here only faintly indicated in its proximal portion. The sac is distinctly elongated and slightly flattened, not paddle shaped, as it is usually represented in the embryos. It terminates in a long filiform projection which extends dorsalward beyond the transverse sinus, to the medial side of which the sac lies; within it a minute lumen is clearly traceable. The projection is surrounded by a bed of vascular connective tissue (fig. 19).[17]

As shown by reconstruction, the space within the cartilaginous capsule has already essentially attained certain features of adult character (figs. 11 and 12). The cochlea, beginning at the round window, makes slightly over two complete turns. Its medial wall is somewhat convex, with no irregularities, and is unbroken except at the entrance of the acoustic nerve. The outline of the spiral septum can scarcely be traced (fig. 12). The lateral surface, however, displays the spiral turns distinctly (fig. 11). The first turn is separated from the acoustic nerve and the vestibular region by a deep cleft, corresponding to the proximal end of the spiral septum; this cleft is continuous under the superior division of the vestibular nerve as a broad channel, the space for the transverse crest, with a deep cleft on the medial side of the cochlea just superior to the singular canal (fig. 11). Between the lateral margin of the cochlear window and the upper edge of the first turn of the cochlea is a low elevation marking the location of the promontory.

The semicircular canals have relationships to one another similar to those of the corresponding ducts. Ampullary dilatations are already discernible. The angle between the lateral and the posterior canal is slightly less than in the mature ear. There is a small unchondrified area on the anterior crus of the lateral canal, just behind the body of the incus, through which the space of the cartilaginous labyrinth is continuous with the exterior of the capsule (figs. 11 and 17). The common crus is a short, thick stalk which receives the superior and

17. For no. 886 the usual broad, blunt flattened spindle is described, prolonged as a fine distal extremity. In Ia the endolymphatic duct "does not end in a sac, but becomes a long, narrow, fusiform dilatation, shortly after emerging from the foramen, and gradually decreases in size to be prolonged, at its dorsal extremity, into a fine, lumenless filament or cord of cells" (Macklin,[6] 1914). Its form in numerous human embryos has been described by B. J. Anson (The Distal Projection of the Endolymphatic Sac in Human Embryos, Anat. Rec. **57**:53-58, 1933). The development of vessels and venous sinuses in the territory of the endolymphatic sac has been fully described by G. L. Streeter (The Development of the Venous Sinuses of the Dura Mater in the Human Embryo, Am. J. Anat. **18**:145-178, 1915; The Vascular Drainage of the Endolymphatic Sac and Its Topographical Relation to the Transverse Sinus in the Human Embryo, ibid. **19**:67-90, 1916).

the posterior canals, joining the vestibule on its posteromedial wall, immediately behind the space for the endolymphatic duct. Stretching from the inferior side of the vestibular nerve to the ampulla of the posterior canal is the singular canal, the pathway of the branch of the vestibular nerve which supplies the ampulla of the posterior canal (fig. 12). The acoustic nerve passes through the medial capsular wall in close association with the facial nerve, while within the foramen they diverge, the facial nerve passing laterally over the transverse crest and into the tympanic cavity (figs. 12, 15 and 16). In both nos. 317 and 886 the spherical and elliptic recesses are rudimentary. The posterior portion of the vestibular cavity, the apex of which receives the simple crus of the lateral canal, is distinctly pyramidal and flattened anteroposteriorly; with this exception the form of the vestibule of the embryonic ear closely resembles that of the adult.

Mesenchymal vacuolation in the areas later to be occupied by the large periotic spaces has begun in the 29 mm. embryo. Multiple small disconnected cavities have appeared, some of which are vascular spaces lined by endothelium while others are true forerunners of the periotic spaces, certainly identifiable only where the loose lining cells have united into a thin but regular membrane. Since the clefts are small and scattered, they have not yet formed cisternae; however, spaces are most numerous in the region of the future cisterna vestibuli, situated immediately within the vestibular window, behind the base of the stapes (fig. 18). The spaces forming around the semicircular ducts are extremely small; those of the scalae are somewhat larger (yet smaller than those of the vestibular region). The vestibular and the cochlear space lie in a richly vascular bed of mesenchyme.[18]

The epithelium of the membranous labyrinth in no. 317 already exhibits moderate regional differentiation. In the semicircular ducts the epithelium is of the low cuboidal type, usually no more than one layer thick. The walls of the ampullae have a thickness of one layer on the medial side and of from two to four layers on the lateral side, the site of the developing cristae, whose cells are columnar and arranged in pseudostratified form. These cells belong to the future neuro-epithelial layer, which lies just beneath the gelatinous cupola of the crista; they

18. G. L. Streeter (The Development of the Scala Tympani, Scala Vestibuli, and Periotic Cistern in the Human Embryo, Am. J. Anat. **21**:299-320, 1917) stated that "the earliest histological evidence of the formation of the perioticular spaces occurs near the stapes in the reticulum lying between the sacculus and the fenestra vestibuli, where, in embryos between 30 mm. and 40 mm. long, it can be seen that its meshes are becoming irregular and its spaces are beginning to coalesce. This constitutes the rudiment of the vestibular cistern. It makes its appearance before there is any trace of the scalae, but it is not until the fetus becomes about 50 mm. long that the cistern is definitely outlined and clearly differentiated from the adjoining reticulum."

are in marked contrast to those of the lower, single layer forming the opposite (inner) ampullary wall. These observations agree with those of Streeter[3] (1906) on the 30 mm. embryo. The epithelium of the utricle and the saccule is essentially the same as that of the ducts, except where it forms the maculae acusticae. Each macula consists of a two-layered palisade of low columnar cells resting on a basement membrane and a thin, inner, more cellular lining surmounted by cilia. Assumedly the members of the inner layer are the future tufted hair cells. The walls of the cochlear duct are in general from three to six cells thick, the cells varying between a high and a low cuboidal type. Differentiation into types of cells in the organ of Corti has not begun. Cuboidal cells, in single or double layers, form the thin walls of the endolymphatic duct, sac and projection, without regional difference. The lateral wall of the sac lies in direct contact with the medial wall of the transverse sinus (fig. 19).

There is some suggestion of papillary folds on the canalicular epithelium, but this is more marked, though still primitive, in the epithelial walls of the utricle and the saccule (figs. 17 and 18). The valve at the utriculo-endolymphatic communication is well formed. The entire valvular mesenchymal tissue is conspicuously vascular.[19]

The vessels in the vascular plexus surrounding the endolymphatic sac are continuous with the transverse sinus in at least two places, at one by a relatively large vessel, the vein of the vestibular aqueduct, which lies

19. In the 29 mm. embryo there occurs only the slightest indication of the complex plication of the duct and sac which appears so prominently in child and adult alike. However, as noted before, the vascularization of the surrounding connective tissue in which it lies is already a feature in no. 317 (with communications between this capillary plexus bed and the transverse sinus). This is in agreement with the observations of Streeter in 1916[17] on the vascular drainage of the sac in the 20 mm. embryo. This capillary plexus in the connective tissue, together with the complex folding of the epithelial wall, is regarded by B. J. Anson and J. G. Wilson (The Form and Structure of the Endolymphatic and Associated Ducts in the Child, Anat. Rec. **65**:485-498, 1936) and by Anson and J. P. Nesselrod (Endolymphatic and Associated Ducts in Man, Arch. Otolaryng. **24**:127-140 [Aug.] 1936) as meeting the anatomic requirement for a resorptive mechanism for the endolymph, in support of the earlier contention of S. R. Guild (Observations upon the Structure and Normal Contents of the Ductus and Saccus Endolymphaticus in the Guinea Pig [Cavia Cobaya], Am. J. Anat. **39**:1-56, 1927; The Circulation of the Endolymph, ibid. **39**:57-81, 1927) based on experimental evidence. The valve of the utriculo-endolymphatic communication (fig. 18) was first described by T. H. Bast (The Utriculo-Endolymphatic Valve, Anat. Rec. **40**:61-65, 1928). Its development has since been followed by B. J. Anson (The Early Development of the Membranous Labyrinth in Mammalian Embryos, with Special Reference to the Endolymphatic Duct and Utriculo Endolymphatic Duct, Anat. Rec. **59**:15-25, 1934) and its function discussed by Bast (The Utriculo-Endolymphatic Valve and Ducts and Its Relation to the Endolymphatic and Saccular Ducts in Man and Guinea Pigs, Anat. Rec. **68**:75-97, 1937) and others.

posterolateral to the sac and at another by smaller vessels of the plexus around the tip. The walls of these vessels are a single-layered endothelium.

The anterior or motor root of the facial nerve joins the larger and more posterior sensory root (nervus intermedius) between the otic capsule and the brain, the conjoined nerve then passing in close contact with the acoustic nerve to the anterior portion of the internal acoustic meatus. Passing under the suprafacial commissure, the facial nerve courses in an almost straight line to the tympanic end of the foramen named for it (figs. 1 and 15); here it enters the geniculate ganglion. The motor fibers continue directly toward the rudimentary stylomastoid foramen, carrying with them a portion of the fibers from the ganglion, while extending anteriorly as a thin strand the greater superficial petrosal nerve carries most of the remaining fibers from the ganglion (figs. 15 to 19). The spiral ganglion is a thick mass of nerve tissue closely duplicating the turns of the cochlear duct (fig. 15). The fibers arising from this ganglion pass toward the internal acoustic meatus spirally and crowded closely together, the nerve itself not being easily separable from the vestibular nerve in the space between the meatus and the brain stem.[3] The vestibular ganglion is an extensive falciform mass of tissue with the convexity directly medialward (fig. 16). It begins under the suprafacial commissure (but not in contact with it) on a level with the facial nerve. It does not reach the lateral edge but projects well beyond the medial edge of the commissure. It begins 0.1 mm. anterosuperiorly to the cochlear hiatus of the internal acoustic meatus, and it is deeply embedded in the superior vestibular foramen; coursing inferoposteriorly, the ganglion ends in an elongate process in the inferior vestibular meatus. The rootlets of this ganglion can be traced for a short distance toward the ampullae, the recess for the utricle and the saccule. The singular canal, which accommodates the posterior ramus of the vestibular nerve to the ampulla of the posterior canal, has already been discussed.

The cartilage of the capsule is made up of young cells loosely arranged; their cytoplasm is light staining and their nuclei large. Near the periphery of the capsular wall the cells are more compact and merge eventually with the cells of the perichondrium; in such locations as the margin of the vestibular window and in the tegmen tympani it is impossible to determine with certainty where the one ends and the other begins. The angular mass composing the bulk of the canalicular portion is the largest single mass of cartilage in the capsule, and in its core the cells are loosely packed. Rarefaction in the areas immediately surrounding the canals is a constant feature.

The fissula ante fenestram is not yet present in the 29 mm. embryo; no budding of the vestibular space toward the tympanic cavity is to be

seen anywhere in the region anterior to the vestibular window, nor is there indentation suggestive of a tympanic orifice. There was no hint of differentiation of tissue which would suggest the early formation of the fissula post fenestram.[20]

The tympanic cavity in no. 317 extends as far as the manubrium of the malleus, still embedded in the loose mesenchyme (figs. 17 and 18). Around the pharyngeal end of the auditory tube (which is of earlier development) the mesenchyme has already changed to precartilage; it is continuous with the rapidly growing cartilage of the pharynx and the hard palate. Near the pharyngeal end of the tube the epithelial layer is from three to five cells thick and cuboidal; at the tympanic end it is made up of cuboidal cells only one cell thick.

The stapedial muscle, still rather indefinite at its proximal end, arises just anterior to the mastoid cartilage and passes medially under the styloid process; where it passes just medial to the facial nerve it is a well developed structure. Since there is no pyramid at this stage, the tendinous attachment to the posterior surface of the neck of the stapes is more definite than is that to the capsular wall (figs. 18 and 19). The tensor tympani muscle arises from the cartilaginous portion of the auditory tube; throughout its length this muscle is much larger than the stapedius. It passes backward along the medial tympanic wall and lies free in the mesenchyme of the tympanic cavity, since the semicanal is not yet formed. It attaches laterally to a low tubercle on the manubrium (figs. 15 and 16).

CONCLUSIONS

Since this study has as its object not only a description of the otic capsule (and contained and externally related structures) in the 29 mm. human embryo but also a comparison of this ear with that of embryos already described by other investigators, it seems that both purposes may be served by showing in tabular form the salient anatomic features in each.

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20. Bast in 1933[13] studied fifty-six human fetuses ranging from 8 weeks to full term. The youngest fetus to show a fissula was one of 43 mm. (crown-rump) length. In the next youngest specimen studied, of 30 mm. (crown-rump) length, the fissula could not be found. He concluded, therefore, that the fissula must become differentiated between the 30 mm. and the 43 mm. stage. The fissula in postnatal stages has been described and figured by Bast (Development of the Otic Capsule: III. Fetal and Infantile Changes in the Fissular Region and Their Probable Relationship to the Formation of Otosclerotic Foci, Arch. Otolaryng. **23**:509-525 [May] 1936), Anson and Wilson (The Fissula Ante Fenestram in an Adult Human Ear, Anat. Rec. **56**:383-393, 1933), Anson and Martin (Fissula Ante-Fenestram: Its Form and Contents in Early Life, Arch. Otolaryng. **21**:303-323 [March] 1935) and J. G. Wilson (Fissula Ante Fenestram and the Adjacent Tissue in the Human Otic Capsule, Acta oto-laryng. **22**:382-389, 1935), especially in regard to the relation of its complex histologic picture to the occurrence of otosclerotic foci.

Table of Comparisons

Structure	No. 325 1.6 mo., 20 mm. (Crown-Rump)	No. 317 1.87 mo., 29 mm. (Crown-Rump)	No. 886 1.86 mo., 43 mm. (Greatest Length)	"Ia" 2.2 mo., 40 mm. (Crown-Rump)
Supracochlear cartilage	Absent	Absent	Absent	Present
Allcochlear commissure	Present; does not unite with cochlear capsule	Present; definitely united with cochlear capsule	Present; definitely united with cochlear capsule	Present; not united to cochlear capsule; undergoing retrogression
Completeness of carotid canal	Incomplete	Complete	Complete	Incomplete
Mastoid cartilage	Well developed	Either absent or just beginning	Present	Well developed
Parotic crest	Same stage as in no. 317	Low, rounded eminence; not prominent	More prominent than in no. 317	More prominent than in no. 886
Tegman tympani	Primitive bud	Rapidly growing flange of cartilage	Same as in no. 317	Not much advancement
Endolymphatic foramen	Large	Relatively smaller than in no. 325	Same stage as in no. 317	Not much change since 29 mm. stage
Degree of chondrification of capsule	Not determined	Complete except for small area in canalicular capsule	Same stage as in no. 317	Complete
Suprafacial commisure	Incomplete	Complete but narrow	Complete	Well developed
Intraperilymphatic processes	Beginning	Posterior: a definite structure; anterior: rudimentary	Both posterior and anterior better developed than in no. 317	Well developed but not yet fused
"Fenestra perilymphatica"	Primitive	Fairly well defined but not separate from jugular foramen	Edges a little more definite than in no. 317	More advanced than in no. 886 but not yet divided
Subarcuate fossa	Shallow	A deep depression	Deep and well developed	Deep and well developed
Shape of stapes	Not determined	Ring	Ring	Ring
Attachment of short leg of incus to capsule	Not determined	By perichondrium	By young cartilage	Membranous; approximates that of adult
Spiral septum	Not discussed	Well developed; rapidly growing	Rapidly growing; somewhat lower than in no. 317	Not discussed
Turns of cochlear duct	Not determined	Slightly over 2 turns	1¾ turns	About 2 turns
Gonlale	Absent	Absent	Absent	Present but not connected to malleus
Fissula ante fenestram	None	None	None	Not mentioned
Vacuolation of periotic space	Not determined	Just beginning behind stapes	Not determined	Not enough advanced over no. 317 to allow for modeling
Folds in epithelium of membranous labyrinth	Not discussed	A few low folds	Not discussed	Not discussed
Shape of endolymphatic sac	Not discussed	Long, fusiform, slightly flattened	Broad and paddle shaped	Long and fusiform
Development of maculae and cristae	Not discussed	Beginning differentiation of layers of cells	Not discussed	Not discussed
Distal projection of endolymphatic sac	Not discussed	Contains a fine lumen	Contains a fine lumen	No lumen
Foramen for vein of endolymphatic duct	Absent; common foramen	Present; distinctly separate from foramen for duct	Absent; common foramen	Absent; common foramen
Stapedial artery	Not discussed	Not identified	Not discussed	Not discussed

INTERPRETATION OF RESULTS OF TUNING FORK TEST FOR DEAFNESS

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WASHINGTON, D. C.

The use of the tuning fork test is universal. However, the interpretation of the results is open to wide variation, depending on the experience of the physician performing the test. In many cases, owing to lack of knowledge of the proper results to be derived from the tuning fork test, the results are valueless. Fowler [1] said:

> The employment of the older standard tuning fork tests, the lack of appreciation of their possibilities, their careless use and interpretations, and the variation between instruments, results in a snare and delusion.

The present trend to the use of electrical instruments has come partially as a result of this lack of proper knowledge of the use of tuning forks, but for many a practitioner it has increased the uncertainty in the interpretation of the type and the degree of deafness. The increasing number of electrical instruments, each with its own type of graph and its own interpretation according to factory instructions, has not led to a clearing of this problem. The work of the Bureau of Standards, at Washington, D. C., during the last two years, instigated by the need for audiometers in different departments of the government, is a definite step in the right direction. Owing to the efforts of the Bureau of Standards, there has been a trend toward standardizing the evaluation of air conduction in audiometers. As the different makers of instruments adopt this standard, the possibility that other concerns will follow suit seems strong. (Those so far having adopted the specifications of the Bureau of Standards are Western Electric, Sonotone and Pillings.) Although the measurement of air conduction has been standardized, so far there is no means of standardizing the measurement of bone conduction, which is an important factor in the accurate determination of the extent and the type of deafness.

Tuning forks in the hands of a physician should be an accurate and inexpensive means of distinguishing the type of deafness of a patient, but unless the procedure and the method of interpretation are uniform, the findings are valueless for any other physician who may examine

1. Fowler, E. P.: Newer Tests for Hearing, Laryngoscope **37**:285, 1927.

the results of the tuning fork test. How to make the tuning fork test a part of one's record and of permanent value has undoubtedly been considered by every physician practicing otology. This paper offers a graph for the interpretation of the results of the tuning fork test which seems a logical means of charting the findings. Careful search of the literature at the Army Medical Library, Washington, D. C., revealed only two reports dealing with this subject, one by Hallpike [2] in 1927 and the other by Roth [3] in 1932.

A set of tuning forks purchased from a reliable surgical supply house consists of five forks, each fork of a given frequency, ranging from 128 to 2048 double vibrations. The forks will vibrate for a given period, depending on their size. The forks used in this report were of Hartmann manufacture; equally reliable forks of other makes may be employed. The blows given a fork should be uniform, a result which is best accomplished by the use of the pleximeter, as explained by Macfarlan.[4] The time of vibration of a fork of 512 double vibrations will be approximately ninety seconds by air conduction when hit a standard blow. If the same fork is placed behind the auricle for bone conduction, the person with normal hearing will hear the sound produced for approximately thirty seconds. Similar findings may be obtained for the remaining forks in the set, but the sound produced is heard for variable periods, depending on the size of the fork. However, as stated before, the duration of the sound produced by a fork of a given tone will be approximately the same, as follows:

Normal Hearing Time for a Set of Tuning Forks

Tuning Fork, D. V.	Bone Conduction, Seconds	Air Conduction, Seconds
128	20	35
256	20	30
512	30	90
1024	30	60
2048	12	35

METHOD

Before beginning to test deaf patients it is important to test the set of tuning forks to be used on a series of patients, known to be normal, to obtain a standard from which to work. When the normal values for the set of tuning forks are known, it becomes simple to interpret variations from normal. The interpretation is made still easier if the results of the hearing test are graphed.

2. Hallpike, C. S.: Suggested Graphic Method of Representing Tuning Fork Tests, J. Laryng. & Otol. **42**:322, 1927.

3. Roth, A.: Graphic Method and Chart for Hearing Test with Tuning Forks, Arch. Otolaryng. **15**:834 (June) 1932.

4. Macfarlan, D.: Standardizing the Tuning Fork, Arch. Otolaryng. **7**:234 (March) 1928.

As an aid in quickly recording the findings at the time of examination, the following form may be used:

Form 1

Name..... Date.....

Air Conduction	Right	Left
128		
256		
512		
1024		
Bone Conduction		
128		
256		
512		
1024		
2048		

Before transferring the findings of a hearing test to a graph it is necessary to make them comparable by bringing them all to a common base.

In the tabulation under bone conduction the largest figure is thirty seconds, the time during which the average patient will hear the 512 double vibration tuning fork by bone conduction.

To convert the remaining figures in the bone conduction column to the largest common figure, so that a standard will be obtained, it is necessary to multiply each figure by a fraction determined by using the largest figure as the numerator and the other figures as denominators.

Thus, 30/20 becomes 3/2; this fraction multiplied by the smaller figure ($20 \times 3/2$) equals 30. By the same procedure, 30/12 becomes 5/2, and $12 \times 5/2$ equals 30. Thus, each value is brought up to 30 as normal. A similar procedure for the air conduction column brings all figures to 90 as normal. The computations follow:

Tuning Fork, Double Vibrations	Normal Bone Conduction
128	$20 \times 3/2 = 30$ $(30/20 = 3/2)$
256	$20 \times 3/2 = 30$ $(30/20 = 3/2)$
512	$30 \times 1 = 30$ $(30/30 = 1)$
1024	$30 \times 1 = 30$ $(30/30 = 1)$
2048	$12 \times 5/2 = 30$ $(30/12 = 5/2)$

Tuning Fork, Double Vibrations	Normal Air Conduction
128	$35 \times 18/7 = 90$ $(90/35 = 18/7)$
256	$30 \times 3 = 90$ $(90/30 = 3)$
512	$90 \times 1 = 90$ $(90/90 = 1)$
1024	$60 \times 3/2 = 90$ $(90/60 = 3/2)$
2048	$35 \times 18/7 = 90$ $(90/35 = 18/7)$

When the figures in a particular case have been reduced to a common level by multiplication by the fractions established for the various forks, it is possible to plot the findings as determined by the tuning forks on a graph (chart 1), separate charts being used for air and for bone conduction. Should the 512 double vibration fork which is used have a different duration of vibration, which it probably will—say, sixty seconds or one hundred and twenty seconds, instead of ninety seconds, for air conduction, and twenty or forty seconds for bone conduction—the normal values on the chart will be placed at that level.

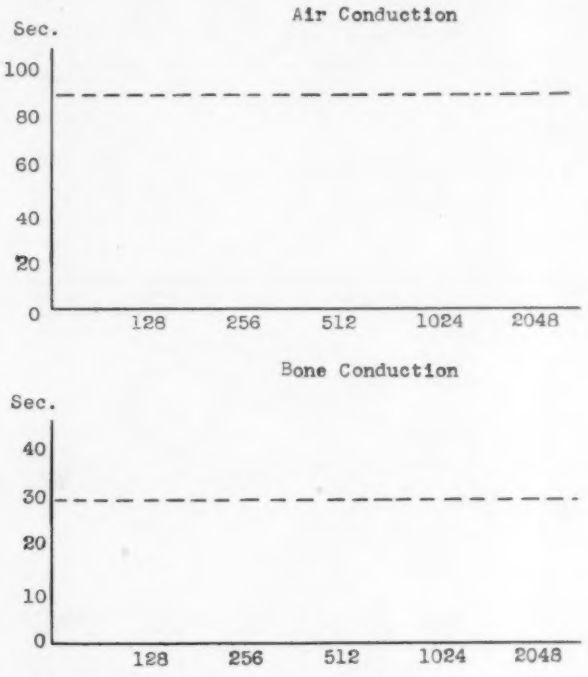

Chart 1.—Form for plotting results of hearing test.

The use of separate charts for air and for bone conduction prevents complications and gives a quick understanding of the type of deafness present.

Example: A patient comes into the office, and the hearing test with the tuning forks gives the following figures:

Tuning Fork, Double Vibrations	Air Conduction		Bone Conduction	
	Right	Left	Right	Left
128	40	25	10	8
256	25	16	5	4
512	45	40	0	0
1024	27	20	0	0
2048	14	7	0	0

By multiplying these figures by the fractions for the respective tuning forks the following figures are obtained:

Tuning Fork, Double Vibrations	Air Conduction		Bone Conduction	
128	40 × 18/7 = 100	25 × 18/7 = 64	10 × 3/2 = 15	8 × 3/2 = 12
256	25 × 3 = 75	16 × 3 = 48	5 × 3/2 = 8	4 × 3/2 = 6
512	45 × 1 = 45	40 × 1 = 40	0 × ... = 0	0 × ... = 0
1024	27 × 3/2 = 40	20 × 3/2 = 30	0 × ... = 0	0 × ... = 0
2048	14 × 18/7 = 36	7 × 18/7 = 18	0 × ... = 0	0 × ... = 0

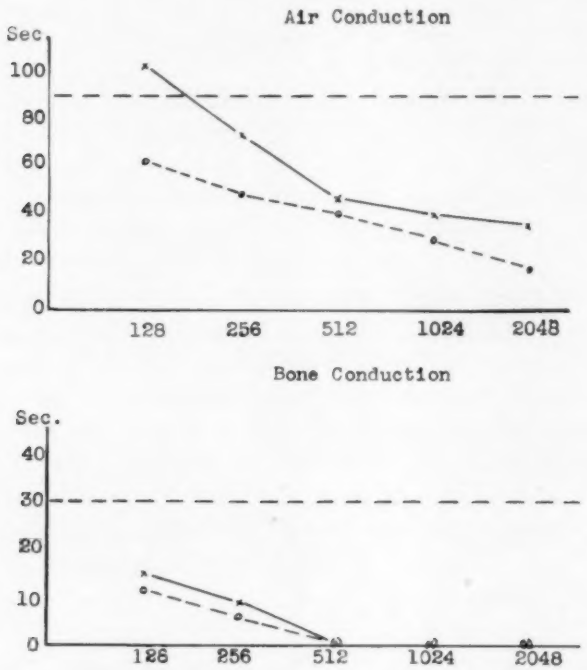

Chart 2.—Graphic representation of results of hearing test for Mrs. A. H. (case 1), recorded July 3, 1937. The horizontal line represents the normal level; the circles indicate values for the left ear, and the crosses, those for the right ear.

When these figures are charted they will produce the graph found in chart 2.

After the figures have been obtained by the examiner, they can be turned over to any member of the office for completion of the computations and charting, for which ordinary graph paper is used.

The form of the graph produced for any one patient will be the same regardless of the forks used; and if conditions are as near perfect as possible, outside of individual variations, it should be duplicated by a different examiner.

The simplicity and accuracy of this means of recording the results of a hearing test should speak for themselves. It requires no previous training or knowledge of the graph to diagnose a hearing condition quickly and accurately, regardless of the forks used in the hearing test.

A number of graphs, with a short summary of the cases illustrated, will show how adaptable is this method of recording hearing tests, which I have used in testing over 500 patients in the last two years.

CASE 1.—Mrs. A. H., aged 51 years, was first seen on July 3, 1937. She complained of a gradual progressive loss of hearing for the past ten years.

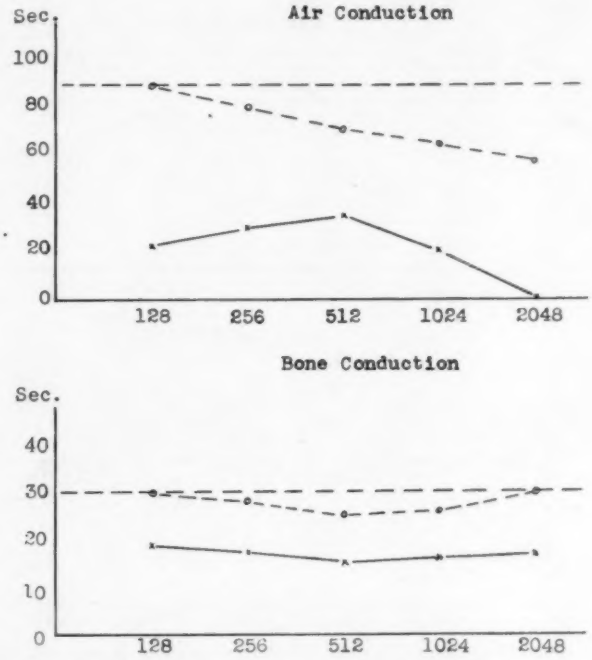

Chart 3.—Graphic representation of results of hearing test for Mr. G. W. (case 2), recorded July 12, 1937.

She had had occasional colds for three years, but there was no history of previous aural trouble. She had one living brother whose hearing was normal. The mother and the father first noticed difficulty in hearing at 55 and 60 years, respectively; both lived to be 86 years old. Examination showed the ears to be of normal appearance, with slight retraction of the tympanic membrane, patent eustachian tubes and chronic mild nasopharyngitis. A diagnosis of bilateral nerve deafness, greater on the left than on the right side, was made (chart 2).

CASE 2.—Mr. G. W., aged 32 years, was seen March 10, 1936. He complained of difficulty in hearing since childhood. There was a discharge from the right ear following scarlet fever at 2 years of age; this recurred at intervals until

1927, when it stopped until 1932, then returned and persisted up to the time of examination. The patient had frequent colds and experienced difficulty in hearing between the ages of 10 and 16 years. There was a discharge from the left ear during the same period. There had been no operations on either ear. There had been no deafness in the family. Examination showed a perforation of the right tympanic membrane; the middle ear appeared moist and glistening. The left tympanic membrane had a small perforation and was dry. There was no attempt to inflate the eustachian tubes. There were chronic rhinitis and moderately severe involvement of the ethmoids and the antrums. The nasopharynx was chronically inflamed. A diagnosis of bilateral nerve deafness, greater on the right than on the left side, and conductive deafness in the right ear was made (chart 3).

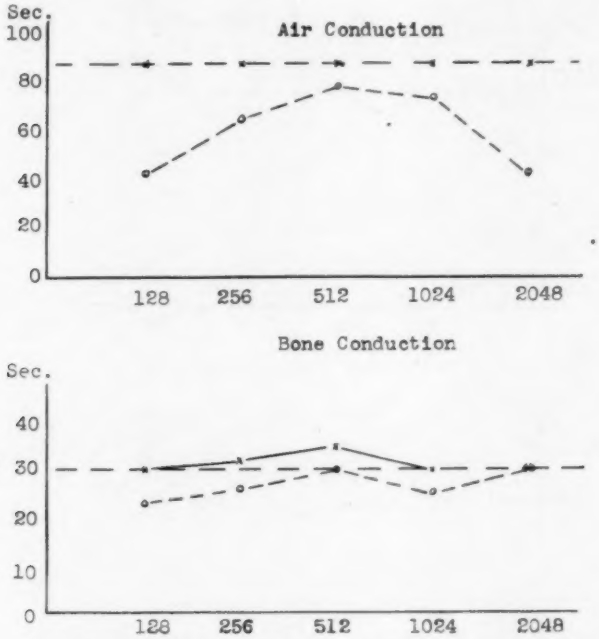

Chart 4.—Graphic representation of results of hearing test for E. B. (case 3), recorded May 21, 1936.

Case 3.—E. B., a boy aged 16 years, had a mastoidectomy on the left side on March 23, 1936. The previous history was irrelevant. There had been no trouble with the right ear. A hearing test was done May 21, 1936, and the diagnosis was conductive deafness of the left ear. A hearing test performed six months later showed the hearing to be normal (chart 4).

Case 4.—C. F., a boy aged 5 years, was hit by an automobile on Oct. 31, 1935. He was knocked 12 feet (3.7 meters) and received a severe bruise on the right side of his head. The parents stated that the child had difficulty in hearing in the right ear after the accident. He was first seen on April 16, 1936, at which time examination of the ear showed no abnormality. A hearing test was performed on the same day, and the diagnosis was bilateral mixed deafness, i. e., both

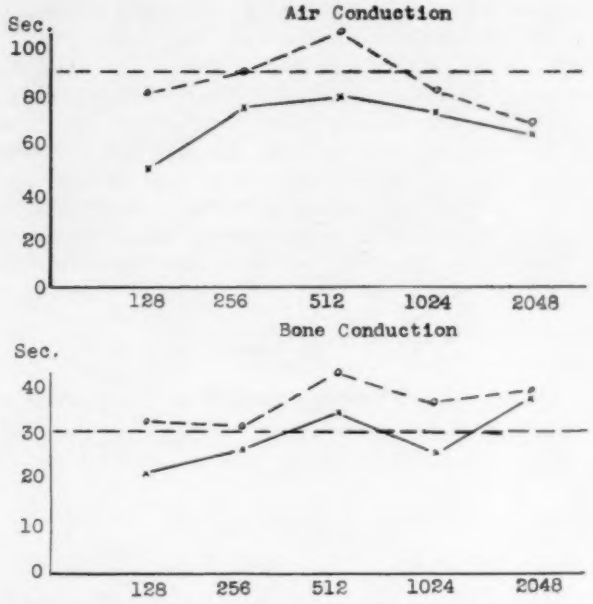

Chart 5.—Graphic representation of results of hearing test for C. F. (case 4), recorded April 16, 1936.

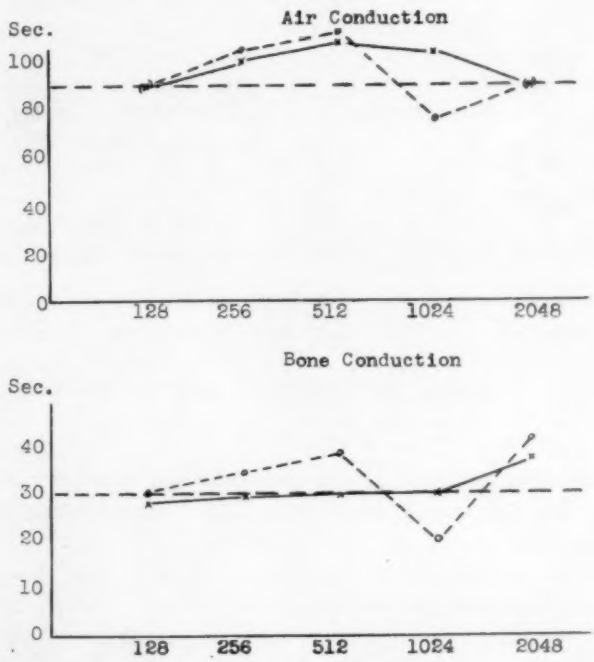

Chart 6.—Graphic representation of results of hearing test for Mr. M. M. (case 5), recorded Oct. 23, 1935.

conductive and nerve deafness, with the hearing of the right ear consistently below that of the left for all tones tested (chart 5).

CASE 5.—Mr. M. M., aged 22 years, had no difficulty in hearing but had mild chronic pansinusitis. A hearing test showed a nerve deafness for the 1,024 double vibration tuning fork of approximately 30 per cent (chart 6).

CASE 6.—Mrs. W. B., aged 42 years, was first seen Feb. 20, 1936, because of deafness, which was first noticed in March 1936 and had increased up to the time of examination. The patient complained of vertigo, which began in December 1933 and had been present nearly ever since. Examination showed moderate retraction of the tympanic membrane of each ear, with no inflammation, closure of both eustachian tubes, mild bilateral ethmoiditis, chronic inflammation of the

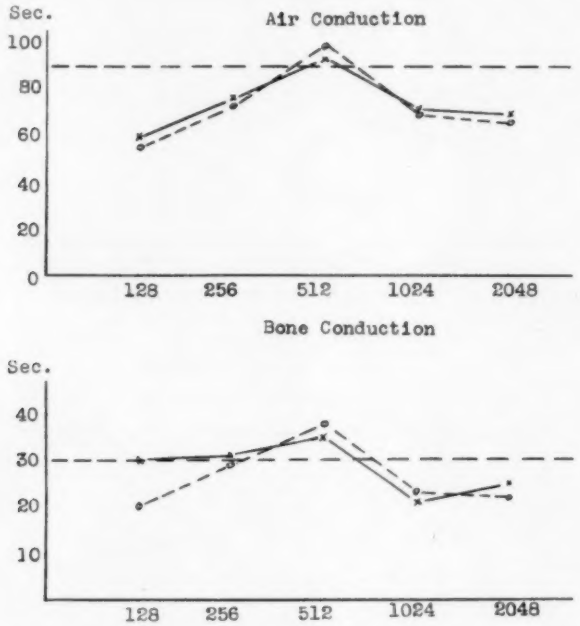

Chart 7.—Graphic representation of results of hearing test for Mrs. W. B. (case 6), recorded Feb. 20, 1936.

tonsils and a dead first right molar tooth. A diagnosis of bilateral mixed deafness was made (chart 7).

CONCLUSION

The use of tuning forks as a diagnostic aid is of decided benefit, and the hearing loss can be interpreted and recorded accurately by the method described.

The use of two graphs leads to less confusion and offers a means of comparing bone and air conduction.

The use of the tuning forks as here suggested does not mean the elimination of the audiometer but offers an accurate means of checking its findings.

NASOPHARYNGEAL FIBROMA

REPORT OF A CASE IN WHICH A SURGICAL APPROACH WAS EMPLOYED

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A nasopharyngeal fibroma which was resistant to radium (advocated by Parish and Pfahler,[1] New and Havens,[2] Mertins[3] and Persky[4]) and inaccessible for electrolysis (advocated by Delavan[5] and Forster[6]) was successfully extirpated by the transantral approach developed by Sewall[7] for the removal of the sphenopalatine ganglion.

REPORT OF CASE

R. S., a boy aged 9 years, was seen on Aug. 27, 1932, because of increasing nasal obstruction, frequent colds, apparently chronic nasal discharge of a few years' duration, frequent mild nosebleed, frequent bronchitis and prolonged fever after colds. The family physician had reported a "growth" in the nose, but the parents had observed no difference between the sides of the nose. Adenotonsillectomy had been done four years ago, after purulent otitis media.

Examination of the nose showed the mucosa to be congested on both sides. There was some mucopurulent secretion, especially around the middle meatuses. After shrinkage a large mass "resembling ordinary nasal tissue" filled the posterior half of the right nasal chamber and extended around the posterior septal edge to be visible through the left side. Its origin was not visible; to the probe it seemed to be at the posterior tip of the middle concha. The mass could be moved slightly. It was somewhat lobulated, "moderately soft though not flabby like the usual nasal polyp," and of the "red color of nasal mucosa." The tonsils appeared

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1. Parish, B. D., and Pfahler, G. E.: Nasal Fibroma—Surgical Removal—Recurrence—Treated by Radiation, Ann. Otol., Rhin. & Laryng. **34**:219, 1925.

2. New, Gordon B., and Havens, Fred Z.: Fibroma of Nose and Nasopharynx, S. Clin. North America **12**:939, 1932.

3. Mertins, Paul S.: Radium Treatment of Nasopharyngeal Fibromata, South. M. J. **21**:711, 1928.

4. Persky, A. H.: Two Cases of Nasopharyngeal Fibroma Treated by Operation Followed by Radium, Laryngoscope **39**:460, 1929.

5. Delavan, D. B.: Nasopharyngeal Fibroma, Tr. Am. Laryng. A., 1911, p. 15.

6. Forster, H. V.: An Advanced Case of Nasopharyngeal Fibroma Treated by Diathermy Coagulation and X-Rays, J. Laryng. & Otol. **46**:402, 1931.

7. Sewall, E. C.: An Operation for the Removal of the Spheno-Palatine Ganglion, Ann. Otol., Rhin. & Laryng. **35**:1, 1926.

to have been well removed. The posterior wall of the throat was hyperemic. The nasopharynx could not be seen. The ears were normal. Roentgenograms showed no signs of a bony tumor or of resorption; there were marked polypoid thickening of the right antral mucosa and slight thickening of the left and slight cloudiness of the left frontal sinus. The diagnosis was obviously nasal tumor, but the type was uncertain. The impression was that it certainly was not malignant, bony, cartilaginous or actually fibroid in consistency; yet the color and consistency were not those of the usual nasal polyp. In view of polypoid changes in the antrums, fibrosed nasal polyp was believed to be the most likely diagnosis, and removal and intranasal drainage of the antrums were advised.

At the first operation (Oct. 31, 1932) a nasal snare was engaged at the base of the "polyp," and avulsion was attempted. The wire of the snare broke, and moderate bleeding started. It was realized at once that the mass was no simple polyp, but it was judged better to continue, since the operation had been started. Dissection of the tumor with a mastoid gouge transnasally, guided by a finger in the nasopharynx, revealed a dense, fibrous, well encapsulated mass invading the sphenoid body through its bony face. A mass about 2.5 cm. in diameter shelled out rather easily, but a lobule remained firmly attached to the lateral wall, just below the region of the sphenopalatine foramen. Dissection was continued from 1 to 1.5 cm. laterally into the sphenomaxillary fossa, when fear of encountering the terminal branches of the internal maxillary artery "around the corner and out of sight" brought matters to a halt. Bleeding was slight, and no pack was required. Moderately severe surgical shock ensued; otherwise, convalescence was uneventful.

The histologic report showed the mass to be composed of new proliferating fibroblasts and old stationary fibrous tissue. The central areas showed both perivascular hyaline and deep myxomatous degeneration. Vascularity was moderate, and the venous sinuses in places were greatly dilated and engorged. There was no evidence of malignant degeneration. The tumor was encapsulated. A diagnosis of benign nasal fibroma undergoing myxomatous and hyaline degeneration was made.

The postoperative course was as follows: On Jan. 1, 1933, the sphenoid cavity was well healed, but there was some fulness on the lateral wall. By February 1 the fulness on the lateral wall was increasing. On March 1 a rounded mass about 1 cm. in diameter at the base could be seen on the lateral wall just below the sphenopalatine foramen. This suggested recurrence. On April 1 no doubt remained as to recurrence. On April 22 a radium pack (25 mg., with a 1 mm. brass filter and 1 mm. of gauze) was applied against the growth for two hours. An observation was recorded on July 22 that the growth had been checked for a while but was increasing again. A 12.5 mg. needle was inserted in the base of the growth for two hours. On December 7 it appeared that there had been a slight decrease for about three months, but the mass was increasing again. Two needles (25 mg.) were inserted in the base for three hours, and on April 1, 1934, the condition seemed stationary. By September 1 the visible growth had not changed, but a severe spontaneous hemorrhage occurred, lasting one hour, and the hemoglobin was reduced to 40 per cent. This impelled me to resort to a second operation.

On October 16, Sewell's transantral approach to the pterygopalatine fossa was taken. An antral window was opened through the canine fossa to avoid an unerupted canine tooth. A window 2.5 cm. square was cut in the posterior antral wall. Blunt dissection through the posterior layer of the periosteum revealed the

internal maxillary, the descending palatine, the sphenopalatine and the infra-orbital artery, each being easily identified, the last as it entered the infra-orbital canal. The main trunk was ligated and cut just distal to the infra-orbital branch. The tissue in the fossa then bulged forward markedly, and further dissection led at once to the capsule of the tumor, which was grasped with a heavy tenaculum through the nose and rapidly shelled out with a blunt Hurd tonsil dissector. Some bleeding from the pterygoid venous plexus in the lower part of the cavity was easily controlled by light packing. Grossly the tumor appeared well encapsulated and lobulated and presented a longitudinal groove along its posterior border, presumably formed by the tubo auditiva, which was immediately behind it as it extended laterally and backward from its point of appearance in the nose. It was 3.5 cm. long by 1.8 cm. in diameter (fig. 1). There was moderate surgical shock, followed by uneventful convalescence. On Jan. 1, 1936, there was no recurrence, and the canine tooth was erupting. By June 1, 1937, there was still no recurrence.

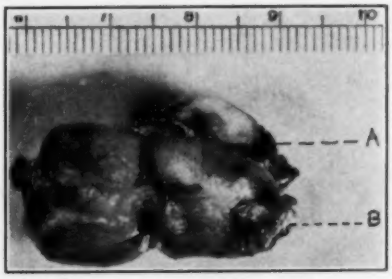

Fig. 1.—Photograph of specimen. *A* indicates the groove presumably formed by the auditory tube; *B*, the mucosal surface in the nose.

Fig. 2.—*A*, composite photograph of the silhouette of the tumor on an antero-posterior film of the sinuses; *B*, composite photograph of the silhouette of the tumor on a lateral film of the sinuses.

Composite pictures (fig. 2), based on roentgenograms of the patient's sinuses, show the relation of the tumor to other structures. Interestingly, there were pain and some stiffness in the lower jaw for the next week.

COMMENT

Radium obviously could only "tickle the end" of this tumor. Coagulation or galvanism would have been dangerous, owing to the proximity of the major arterial branches. Sewall's transantral approach gave excellent access to the pterygopalatine fossa, making possible the execution there of surgical procedures with complete observance of surgical principles, including free visibility, orientation by identification of structures and landmarks, hemostasis by ligature and the avoidance of all deformity or loss of function.

411 Thirtieth Street.

MENINGITIS DUE TO STAPHYLOCOCCUS AUREUS HAEMOLYTICUS

REPORT OF A RECOVERY

MILO FRITZ, M.D.

AND

WILLIAM HOLLISTER

DURHAM, N. C.

The object of this communication is to demonstrate the value of staphylococcus antitoxin as a therapeutic agent in the treatment of an almost invariably fatal disease. Only 4 cases of meningitis due to Staphylococcus aureus haemolyticus in which the disease was successfully treated have so far been reported in the literature. We feel, therefore, that any further contribution to the subject merits attention.

Stout,[1] Shless [2] and Dunlap [3] have each reported a case in detail. Stout referred to still another case but gave no details. The therapeutic agent used in these cases was Staph. aureus bacteriophage. Our case is unique in that it is the first one reported in which recovery followed the use of staphylococcus antitoxin.[4] Dolman [5] referred to 2 cases of meningitis due to Staph. aureus treated with staphylococcus antitoxin. In both cases the patient died. A detailed description of our case follows.

REPORT OF CASE

On Jan. 12, 1937, Dr. N. I. F., of Ayden, N. C., sent to our clinic a 13 year old white boy, C. J., whose chief complaint was earache and swelling behind the right ear of seven days' duration. The family history listed him as the youngest of twelve living children; his father, a farmer, and his mother were both living. His father had mild diabetes, with early bilateral cataract formation and early diabetic retinitis. The boy's birth and development were normal, but when he was at a very early age his mother found that his eyes "danced" (nystagmus) and

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From the Department of Otolaryngology, Duke Medical School and Hospital.

1. Stout, B. F.: Bacteriophage Therapy, Texas State J. Med. **29**:205 (July) 1933.

2. Shless, Robert A.: Staphylococcus Aureus Meningitis, Am. J. Dis. Child. **44**:813 (Oct.) 1932.

3. Dunlap, John E.: Staphylococcus Meningitis with Recovery, J. A. M. A. **104**:1594 (May 4) 1935.

4. The staphylococcus antitoxin used in this case was supplied gratis by the Lederle Laboratories, Inc.

5. Dolman, C. E.: Staphylococcus Antitoxic Serum in Treatment of Acute Staphylococcal Infections and Toxaemias, Canad. M. A. J. **31**:130 (Aug.) 1934.

that they were "weak." At the age of 7 he was fitted with glasses, which he wore continuously up to the time he was admitted to the hospital. He had measles and mumps in infancy and had been troubled with rather severe head colds and attacks of sore throat. There had been no operations and no serious injuries, and there was nothing of further interest in his history.

Twelve days before his admission to Duke Hospital the boy contracted a common cold, with mild tonsillitis. This illness ran the usual course, but seven days before admission to the hospital he noticed pain in the right ear and swelling of the cervical nodes on the same side. The same day chills and fever developed, but his temperature was not taken. The next day a red tender swelling developed over the right temporal region. On the following day the family physician incised the right ear drum. There was profuse discharge of yellow pus, with immediate relief of pain. No material was taken for culture. Two days later, when the drainage ceased, the pain returned. There was anorexia but no nausea, vomiting, headache or dizziness. Two days before the patient's admission to the hospital the tender temporal swelling had extended to the mastoid region, which also became red, swollen and very tender. This condition persisted and was noted at the time of admission. The boy's condition gradually became worse, and he was referred to the clinic for treatment.

Examination on the afternoon of admission showed a tall, thin, acutely ill white boy with a hot flushed face, hot moist skin, red tender swelling over the right mastoid and the right temporal region, a draining right ear and horizontal nystagmus. His temperature was 38.3 C. (100.9 F.); his pulse rate was 100, his respiratory rate was 22, and his blood pressure was 100 systolic and 60 diastolic. The eyes showed, in addition to nystagmus, small, round, equal-sized pupils, which reacted well to light and in accommodation. The ocular fundi showed normal disks and maculas. There was no evidence of increased intracranial pressure. The left ear drum and the left mastoid were normal. The right drum was perforated, and through the perforation welled thick yellow pus. There were considerable tenderness, redness and swelling over the right mastoid and the right temporal region. Hearing was grossly normal in the left ear, but there was deafness of the conductive type in the right ear. The oral cavity was normal. The tonsils were very large and acutely inflamed. The lungs were clear. The heart was not enlarged; the rate was 100, and there were no murmurs. The rest of the physical examination revealed nothing of note. Neurologic examination gave negative results. There was no stiffness of the neck. Kernig's and Brudzinski's sign were absent. The plantar reflexes were normal, as were the abdominal and the cremasteric reflexes.

A blood count showed 12 Gm. of hemoglobin, 4,200,000 red corpuscles and 16,700 white corpuscles, with 78 per cent polymorphonuclears, 4 per cent large lymphocytes, 12 per cent small lymphocytes, 5 per cent eosinophils and 1 per cent monocytes. The Schilling hemogram showed 68 segmented forms, 8 stab forms and 2 juvenile forms. The Wassermann reaction was negative. Examination of the stool gave negative results. The urine was clear lemon yellow and contained an occasional white blood cell, but no red cells, casts, albumin or acetone. The roentgenogram showed some clouding of the right mastoid cells with loss of cell detail. There apparently had been an old infection of the left mastoid also. Two hours after the patient was first seen by us, a mastoidectomy was done on the right side, with light nitrous oxide and ether anesthesia. The mastoid antrum and the immediately surrounding cells were filled with thick yellowish white pus. The lateral sinus was not involved, and the dura appeared healthy. The patient tolerated the operation well. Cultures of the pus yielded Staph. aureus haemolyticus. The pathologic report stated that the condition was acute mastoiditis.

The first three postoperative days were uneventful. The patient's temperature gradually fell to 37 C. (98.6 F.) and stayed at that level for eighteen hours. The patient felt well. Hearing in the right ear was by that time totally lost. Postoperative examinations showed that the blood and urine were normal. The pack was removed from the wound on the first postoperative day, and the patient seemed well on the road to recovery.

In the evening of the third postoperative day the patient vomited his supper, complained of headache and became quite drowsy. His temperature rose to 38.7 C. (101.7 F.). The next morning the temperature rose to 39 C. (102.2 F.) and stayed at that level for twenty-four hours. The left ear drum appeared normal, but it was incised. A small amount of clear fluid, but no pus, was released. A blood count showed 16,640 white corpuscles, with 86 per cent polymorphonuclears, 3 per cent large lymphocytes, 5 per cent small lymphocytes and 6 per cent monocytes. There was no change in the neurologic findings save for a slight increase in nystagmus. Roentgenograms showed moderate invasion of the left mastoid, but a number of clear cells were still present. The right mastoid showed nothing of significance. There was no evidence of destruction along the petrous ridge on either side.

On the fifth postoperative day the patient's temperature rose to 40 C. (104 F.), and later in the day he had a chill, with a rise of temperature to 41.3 C. (106.3 F.). After consultations it was decided that the left mastoid should be explored. A mastoidectomy was done on the left side, with the patient under light nitrous oxide and ether anesthesia. The whole region was markedly sclerotic. The antrum and the surrounding cells were full of thick yellowish white pus. The dura and the lateral sinus were explored and were found to be apparently normal. Culture of the pus yielded Staph. aureus haemolyticus. The pathologic sections showed acute mastoiditis, similar to that on the right side.

Postoperative Course.—Toward the end of the day the patient became drowsy, but he could be aroused and apparently was well oriented, although he was totally deaf. That evening his neck became stiff, and he began to vomit. No petechiae were present, and there was no Kernig or Brudzinski sign. The abdominal, cremasteric and plantar responses were all normal. Early the next morning, the first day after the second operation, his temperature was 40 C. (104 F.), his pulse rate 85 and his respiratory rate 16. A lumbar puncture was done. Twenty-five cubic centimeters of cloudy fluid was removed. The pressure equaled 200 mm. of water. The fluid contained 24,000 white blood corpuscles, with 75 per cent polymorphonuclears and 25 per cent lymphocytes. No organisms were seen. Culture of the spinal fluid yielded Staph. aureus haemolyticus. The Pandy reaction was 3+. Ten thousand units of staphylococcus antitoxin was given intraspinally, after the cutaneous and the conjunctival test were found to be negative. Five cubic centimeters of prontosil [6] was given intramuscularly every four hours. A blood count showed 24,280 white corpuscles, with 87 segmented forms, 11 stab forms, 1 juvenile form and 1 small lymphocyte. That day the fluid balance was controlled parenterally, and a transfusion of 250 cc. of citrated blood was given.

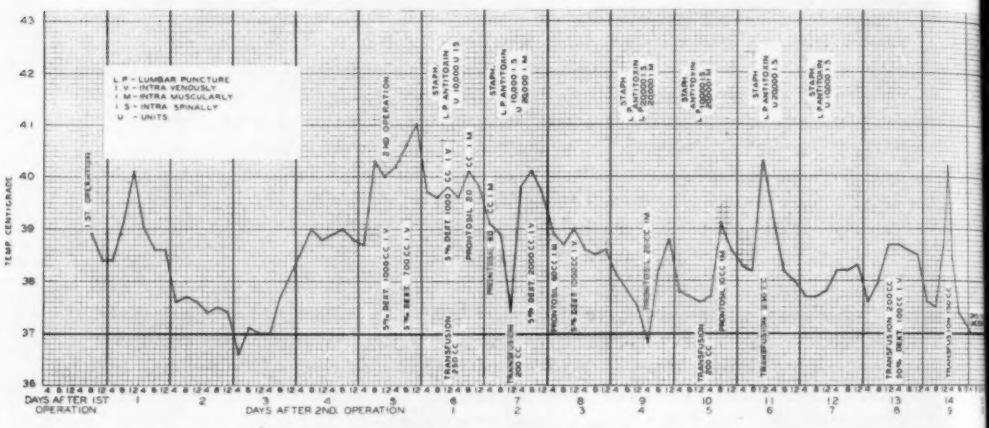
On the second day after the second mastoidectomy, culture of the spinal fluid showed Staph. aureus haemolyticus, but from that time on until the day of the patient's discharge the fluid was sterile. During the remainder of the patient's stay in the hospital he gradually improved. The signs of meningeal irritation subsided quickly. His temperature continued to spike daily, but each day the peak was

6. The term "prontosil" has been applied to various derivatives of sulfanilamide. The preparation used in the case reported here was the disodium salt of 4-sulfamidophenyl-2′-azo-7′-acetylamino-1′-hydroxynaphthalene-3′,6′-disulfonic acid.

less. He was treated constantly and vigorously by intrathecal and intramuscular administration of staphylococcus antitoxin and by blood transfusions and the other usual supportive measures. Prontosil [6] was given intramuscularly for the first few days after the operation.

The patient was finally discharged as cured twenty-seven days after the second operation, when he was able to sit up and walk a few steps without assistance. The right mastoid was almost completely healed, but the left was draining profusely.

Follow-Up One Month After Discharge.—The patient was still rather unsteady on his feet and was completely deaf to everything but the loudest noises. Both mastoid incisions had completely healed. There was a small amount of thick pus in each external auditory canal, and both drums still showed perforations. The tonsils were hypertrophied, and there was a large amount of adenoid tissue. The hemoglobin content of the blood was 75 per cent. It had never fallen below that



It will be noted that 140,000 units of staphylococcus antitoxin, 1,210 cc. of blood and 170 cc. of prontosil [6] were given.

level at any time during his stay in the hospital. He was admitted to the hospital for removal of the tonsils and the adenoids, which was done with general anesthesia. An excellent recovery resulted without complications, and the patient was sent home on the third postoperative day.

Follow-Up Two Months After Discharge.—Two months later the patient had gained weight and strength and was able to play and to do light tasks about the farm on which he lived. He was able to hear the radio when he sat close to it and had it turned on to its full intensity. A 2A audiometer test showed that he was barely able to hear tones from no. 128 through no. 1024 at their greatest intensity in the right ear. The only tone audible in the left ear was no. 512. There was a small perforation in the left drum. The right drum showed marked destruction.

Follow-Up Eight Months After Discharge.—We have been unable to fit the patient with a suitable hearing aid; so he has been sent to the North Carolina School for the Deaf at Morganton, where he is doing satisfactorily.

SUMMARY

The patient was a 13 year old white boy, whose history revealed that he contracted a common cold twelve days prior to the first day on which he was seen by us. Five days later he noticed pain in the right ear. Two days later a myringotomy was done on the right side by the family physician, with release of considerable yellow pus and relief of pain. Two days after this the drainage from the right ear ceased, and there was return of pain, which soon localized in the right mastoid region. Two days later the boy was admitted to the hospital and operated on immediately for mastoiditis. The patient's hearing was destroyed in the right ear, but he was relieved of his symptoms. On the fifth postoperative day mastoiditis developed on the left side. Operation on that side was also performed. The next day the patient showed signs and symptoms of meningitis. Cultures of spinal fluid yielded Staph. aureus haemolyticus on two occasions. This organism had also been found in cultures of material from both mastoids. The patient was energetically treated with staphylococcus antitoxin intraspinally and intramuscularly, with blood transfusions and with prontosil.[6] He made a slow but steady recovery. One month after pronouncement of cure the tonsils and the adenoids were removed. Two months afterward the patient was apparently well except for complete loss of hearing. Ten months after discharge the patient was getting along very well in the North Carolina State School for the Deaf, at Morganton.

COMMENT

The case of a patient who recovered from meningitis due to Staph. aureus haemolyticus of otitic origin, complicated by toxic neuritis of both eighth nerves, is reported.

We think that prompt and thorough treatment with staphylococcus antitoxin and with blood transfusions was the important factor leading to recovery. Prontosil [6] administered intramuscularly may have been an accessory factor. This drug has been shown by Nitti and Bovet [7] to have no effect on staphylococci in in vitro experiments. At no time during our patient's illness was the toxemia severe enough to produce leukopenia, and there was never a shift to the left in the Schilling hemogram.

Joyner and Smith [8] have shown that the ratio of segmented to nonsegmented polymorphonuclear leukocytes is an indication of the severity

7. Nitti, F., and Bovet, D.: Action du 4-sulfonamide-2-4-diaminobenzol (prontosil) sur des infections streptococciques de la souris provoquées par des streptocoques d'origine humaine, Compt. rend. Soc. de biol. **119**:1277, 1935.

8. Joyner, A. L., and Smith, D. T.: Acute Staphylococcus Osteomyelitis, Surg., Gynec. & Obst. **63**:1 (July) 1936.

of toxemia and a convenient guide by which to determine the size of the dose of antitoxin and the frequency of its administration.

Study of the case which we describe suggests that, owing to the early recognition of the nature of the etiologic agent and to the early energetic treatment of the disease, the circulating toxin in the patient's system (at least the leukocidin fraction) was neutralized in time to prevent depression of the myeloid elements of the blood cells and of other cells of the body. The patient was thereby enabled to cope efficiently with the causative organism.

NOTE.—Since this article was submitted for publication, reports of 2 other cases of Staph. aureus meningitis in which the patient recovered have appeared in the literature.[9]

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9. Jackson, R. L.: Staphylococcus Aureus Meningitis, J. Pediat. **11**:518 (Oct.) 1937. Bloch, Harry, and Pacella, B. L.: Staphylococcic Meningitis, J. A. M. A. **110**:508 (Feb. 12) 1938.

POSTOPERATIVE REPAIR OF THE PARANASAL SINUSES

EXPERIMENTAL STUDIES AND THEIR PRACTICAL APPLICATION

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The purpose of this paper is to present experimental data on the reparative processes which follow the radical removal of the mucoperiosteal lining from the paranasal sinuses and their practical application.

In the experiments and the radical surgical operations performed on the sinuses of animals and human beings moderate dissolution was produced in the compact and spongy bone preliminary to the complete removal of the mucoperiosteal lining.

From the specific facts known [1] about the healing of bone and mucous membrane, it is reasonable to postulate that in the healing of the operative area granulation tissue will spring up to repair the bony defects and the sinuses. The intact periosteum of the anterior wall, the endosteum and the cellular elements of the bared bone will form the so-called callus of the long bones. This type of callus differs from the callus of the long bones in that there is a loss of the periosteal lining on the inside of the sinuses and that there is no muscular action around it. There will be, therefore, no reduction of its size during the later period of the healing process. The pseudostratified columnar ciliated epithelium bordering the natural or the artificial opening will proliferate and cover the newly formed tissue. The injured glands of the mucosa of the nose bordering on this area in their process of repair will proliferate and form partly typical and partly atypical glands, but their development will be checked by the rapid formation of scar tissue. One could hardly term such end-results a restitutio ad integrum.

Not all published reports on this subject, however, conform with this view. This fact, coupled with a rare condition which I encountered in

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From the Illinois Eye and Ear Infirmary and the Department of Otolaryngology, Loyola University.

1. Ziegler, Ernst: General Pathology, New York, William Wood & Co., 1908, pp. 274, 286 and 287. Maximow, Alexander A.: A Text Book of Histology, Philadelphia, W. B. Saunders Company, 1931, pp. 167, 173 and 189.

treating the maxillary sinus of a patient, was instrumental in stimulating my interest in the study of this subject.

The history given by that patient, aged 48, was that for the past year she had suffered from severe headaches and neuralgic pains over the left maxilla. All her upper teeth had been extracted five months previously. This operation was followed by a profuse purulent discharge from the alveolar process. Daily irrigation of the left maxillary sinus through the alveolar fistula was performed by her dentist for six weeks. The headaches disappeared, but the pain on the left side of her face persisted. She presented herself for examination in December 1928, because she feared the presence of a malignant growth.

The examination of the edentulous maxilla disclosed no abnormality. The nasal mucosa appeared normal, and there was no evidence of secretion or of intumescence. The roentgenogram showed the left maxillary sinus to be cloudy, although transillumination was good. Irrigation through the natural opening resulted in a return of clear fluid.

On the insistence of the patient I explored this sinus in February 1929. Removal of a portion of the anterior wall, which was friable, disclosed a medium-sized cavity devoid of a mucous membrane. It had the appearance of a well prepared cadaver specimen. Assuming that the neuralgic pain might have been due to the exposure of the nerve endings in the maxilla, I resorted, therefore, to the Denker technic, in order to form a large mucoperiosteal flap, which was laid into the sinus. The patient was relieved of her fears. The neuralgic pains gradually became less severe and disappeared two months after the operation.

About one year later I examined the interior of the sinus with the nasopharyngoscope. It was then noted that the sinus was the same size as before and was lined with a fine translucent membrane. The original flap of nasal mucous membrane presented a sharply defined border where it met the newly formed tissue. Biopsy of this tissue, most important in proof of my contention, was not permitted.

The following questions then presented themselves for solution: What factors were responsible for the occurrence of the previously described pathologic picture in this patient, and was it likely that a similar condition might occur in postoperative repair of the paranasal sinuses?

A search for an answer to those questions was undertaken in the literature and in experimental study of the human maxillary sinus.

REVIEW OF THE LITERATURE

The Frontal Sinus.—Ssamoylenko [2] performed a large number of experiments on the frontal sinuses of animals, in order to ascertain to what extent obliteration can be accomplished without the appearance of external deformity.

When he reopened the sinuses, there was evidence of puslike fluid in one instance, which proved on investigation to be the contents of a

2. Ssamoylenko, M. A.: Verödung der Stirnhöhlen: Experimentelle Untersuchung, Arch. f. Laryng. u. Rhin. **25**:137-154, 1913.

cyst which had formed as a result of an incompletely removed mucous membrane. In none of the specimens was there evidence of mucous membrane growing into the sinus from the nasal cavity. Obliteration of the sinus by new-formed bone and connective tissue was complete by the fifth or the sixth month, although in some animals it had occurred at the end of the first month.

By studying microscopic sections of the new-formed bone, the surrounding bone, the periosteum and the bone marrow from each series of experiments at stated intervals, the author noted that the process of bone building was brought about more by the extreme activity of the endosteum than by that of the periosteum.

He concluded that the degree of obliteration in the human being depends on the state of health of the endosteum.

Hilding's [3] experiments verified to a great extent the results reported by Ssamoylenko, and they offer, in addition, an interesting study of the healing process after the incomplete removal of the mucous membrane.

He removed small strips of mucous membrane from the concave surface of the frontal sinuses of fifteen dogs. On reopening the sinuses from two to thirty-six weeks postoperatively, he observed that the bared areas had healed after two or three weeks with ridgelike scars. The scars were higher and thicker where the denuded strips were wider. When a narrow circular strip of the mucosa was removed from around the ostium of each of two dogs, reinvestigation two weeks postoperatively showed that an imperforate diaphragm had formed in one dog, and in the other only a small opening was still apparent in the diaphragm.

In another series of experiments by Hilding,[4] which consisted in the removal of the entire mucosa from the frontal sinuses of ten dogs, it was noted that in most instances the cavity became completely obliterated with a firm scar. Subsequent studies revealed that the scars were partially ossified. In some instances cysts filled with mucin were found within the scar. Since similar cysts were found in those sinuses in which the author had purposely left islands of mucous membrane, it appeared that their presence signified an incompletely removed membrane. In not every instance, however, did a remaining island of mucosa subsequently form a cyst.

3. Hilding, A.: Experimental Surgery of the Nose and Sinuses: Gross Results Following the Removal of the Intersinous Septum and of Strips of Mucous Membrane from the Frontal Sinus of the Dog, Arch. Otolaryng. **17**:321-327 (March) 1933.

4. Hilding, A.: Results Following Partial and Complete Removal of the Lining Mucous Membrane from the Frontal Sinus of the Dog, Arch. Otolaryng. **17**:760-768 (June) 1933.

An air cavity was found only in a small number of instances. It was much reduced in size when compared with the original sinus, and it communicated with the nose through the ostium, which was not disturbed at the time of the operation.

The author concluded that the poor blood supply, the presence of infection, the openings made for drainage, the retention of blood clots and the anatomic characteristics are factors which may determine the degree of obliteration of the sinus in the human being after the radical removal of the mucosa.

The experiment of Coates and Ersner [5] on the frontal sinuses of one dog concerns itself with the proof that the mucosa from the nose can proliferate and cover the bared sinus after repeated removal. It appears paradoxic, however, that the curetting of the nasofrontal duct in their experiment did not produce a closure of the duct and the ostium and thereby cause a hindrance to epithelial proliferation. One must therefore consider their result as an exceptional instance of the reparative process in a dog.

The Maxillary Sinus.—In addition to experiments with animals, there have been direct experiments as well as autopsies on the human maxillary sinus.

Tonndorf [6] in 1928 published a report of autopsy of a patient who had undergone a radical operation on both antrums, two weeks later had had a mastoidectomy and finally had succumbed to sepsis with multiple hepatic abscesses. The following paragraph is quoted:

> The epithelization process is observed in two places. In one place there is a small island of flat cuboidal epithelium which, judging from its isolated position, must have been a remnant of the previous mucosa of the sinus. The second and more important epithelization process is more interesting. It can be seen from the thick succulent nasal mucous membrane over the margin of the operative window in the inferior meatus that many rows of columnar epithelium have already gone into the sinus cavity. Only the last sharply distal end is still flat, but already even there are signs of cylindric formation.

It is interesting to note that no mention was made of the finding of tubular glands in the newly proliferated epithelium, although the study covered an area at the margin of the nasal mucosa. "The activity of the endosteum, however, was in evidence by the formation of new bone, in spite of the debilitated state of the subject."

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5. Coates, G. M., and Ersner, M. S.: Regeneration of the Mucous Membrane of the Frontal Sinus After Its Surgical Removal, Arch. Otolaryng. **12**:642-648 (Nov.) 1930.

6. Tonndorf: Beitrag zur Ausheilung der nach Luc Caldwell operierten Kieferhöle, Ztschr. f. Hals, Nasen- u. Ohrenh. **22**:54-59, 1928.

Knowlton and McGregor [7] removed the mucosa of the maxillary sinuses of three dogs. The reformed tissue of the sinuses was studied after its removal at the autopsies, which were performed at one, three and five month periods. The 1 month old specimen showed that the newly formed granulation tissue was incompletely covered with a layer of columnar ciliated epithelium, which contained numerous goblet cells. There was no evidence of tubular gland structures. The 3 month old specimen showed a thick layer of fibrous tissue completely covered by pseudostratified columnar epithelium, with an increase in the number of goblet cells. There was no evidence of tubular gland structures in that mature specimen. The 5 month old specimen, however, showed the presence of gland structures. The authors expressed the belief that the gland formations take place in the later stages of the healing process, from outgrowths of the underlying epithelium which become modified into gland cells.

Semenov and Kistner [8] reported the following results in their experiments on the human maxillary sinus: They removed 1 sq. cm. of mucous membrane from the inner wall of the antrum, which is the usual gland-bearing area of the sinus. Four months later this area showed a layer of pseudostratified columnar ciliated epithelium resting on a layer of fibrous scar tissue. No submucous glands were found. In two patients they removed about one third of the membrane. Two years later the entire antral lining was removed for study. The original mucous membrane showed a normal structure, while the repaired portion showed a thick mass of scar tissue, covered in some areas by stratified cuboidal epithelium.

Kistner [9] reviewed the work previously reported by him and Semenov and summarized his investigations on postoperative repair in fourteen human antrums. In one instance the epithelium changed from stratified columnar cells to flat cuboidal cells in a single layer within the same cavity as late as two years after the operation. In another instance a 20 month old specimen showed that the nasal epithelium had ended abruptly by curling downward and that the scar was devoid of epithelium beyond that point. One photomicrograph showed numerous subepithelial glands and a submucosa containing normal blood vessels and

7. Knowlton, C. D., and McGregor, G. W.: How and When the Mucous Membrane of the Maxillary Sinus Regenerates: An Experimental Study in the Dog, Arch. Otolaryng. **8**:647-656 (Dec.) 1928.

8. Semenov, H., and Kistner, F. B.: Repair in the Paranasal Sinuses of Man Following Removal of the Mucous Membrane Lining, Proc. Soc. Exper. Biol. & Med. **27**:322-324 (Jan.) 1930.

9. Kistner, F. B.: Histopathology and Bacteriology of Sinusitis with Comment on Postoperative Repair, Arch. Otolaryng. **13**:225-237 (Feb.) 1931.

erectile tissue, in spite of its location over a thick scar. The author stated that one must not err in interpreting these as new formations, because that tissue was a portion of the original flap of nasal mucous membrane which was laid into the sinus at the time of the operation.

Gorham and Bacher [10] expressed the opinion that the older the specimen may be, the more nearly normal it will appear. According to the report of their experiments, the 1 month old specimen showed a layer of pseudostratified columnar epithelium, with evidence of regeneration of gland structures. The 4 month old specimen showed that the reformed epithelium rested on a loose tunica propria, in which there were numerous well formed mucous and serous glands. In the photomicrograph of a 10 month old specimen from the human antrum there is shown a great abundance of serous and mucous glands, which are seen only in normal nasal mucous membrane.

McGregor [11] examined twenty-six specimens of reformed membranes from human antrums and frontal sinuses and expressed the belief that the mucous membrane after its removal regenerates and is histologically normal. He stated that the mucous membrane must, of course, come from islands left at the operation or grow in from the nose. In some places there is an increase of fibrous tissue; in some places there may be only scar tissue. For some reason, excessive granulation tissue is prone to form in some cases. Undue granulation before epithelization is likely to result in a thickened stroma.

Nasal Mucosa.—Boling's [12] experiments on the mucosa of the nasal septum and of the middle concha of forty sheep shed some light on the problem of the formation of tubular glands. He removed small (average 6 mm.) sections of mucosa and studied the process of healing from twelve hours to sixty days after the operation. Migration of the epithelium, usually by splitting and sometimes by passing over or under the unorganized clot which formed over the injured area, occurs from six to twelve hours after injury. In a month all areas of injury have been covered with completely regenerated ciliated epithelium. Invagination of the epithelial cells into the clot takes place in the early stages of repair, before organization of the clot. No glands were found near the center of the wide areas—which is a further proof that the deep glands arise from the early-formed invaginations at the margins of the injured area. There was no indication of formation of new serous

10. Gorham, C. B., and Bacher, J. A.: Regeneration of the Human Maxillary Antral Lining, Arch. Otolaryng. **11**:763-771 (June) 1930.

11. McGregor, Gregor: Further Proof of the Regeneration of Mucous Membrane in the Human Antrum, Arch. Otolaryng. **14**:309-326 (Sept.) 1931.

12. Boling, LeRoy R.: Regeneration of the Nasal Mucosa, Arch. Otolaryng. **22**:689-724 (Dec.) 1935.

or mucous glands of the type found in the normal epithelium. In conclusion the author stated:

The regenerated mucosa as observed at the end of two months has normal epithelium but has failed to regenerate normal subepithelial structures. The tunica propria is fibrous, lacking the usual vascularity, and the few glands present are probably invaginations of the epithelium of the surface, having failed to regain the normal serum-secreting and mucus-secreting cells.

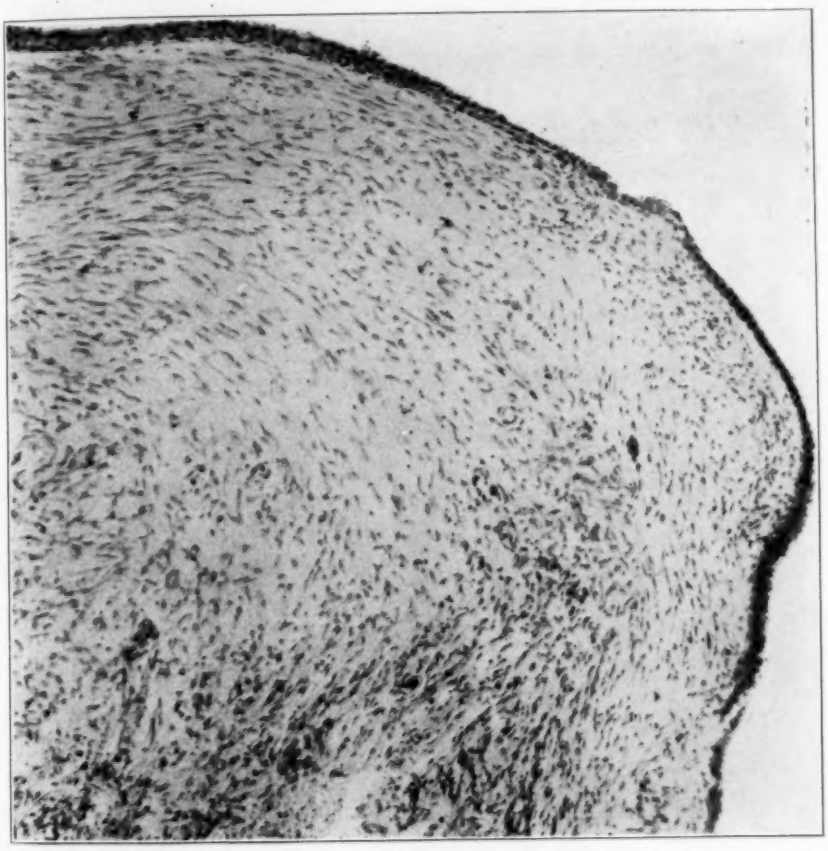

Fig. 1.—Photomicrograph of a section obtained from the superficial surface of the reformed tissue two months after the complete removal of the mucoperiosteum (× 100). A layer of stratified cuboidal epithelium covers a dense layer of fibrous tissue. (No counteropening was made into the nose.)

RESULTS OF EXPERIMENTAL OPERATIONS ON HUMAN BEINGS

All experiments to be reported were performed by me or my associates on the maxillary sinuses of patients at the Illinois Eye and Ear Infirmary during 1931 and 1932 and were repeated in 1936. The

original operations and the subsequent explorations or removals of tissue for biopsy were performed with local anesthesia.

EXPERIMENT. 1.—In a patient who had recurrent polypi in his nose operation was performed on the right maxillary sinus by a modified Caldwell-Luc technic. The entire mucoperiosteum, which was found to be polypoid and hyperplastic, was removed in one mass. No counteropening was made into the nose below the infe-

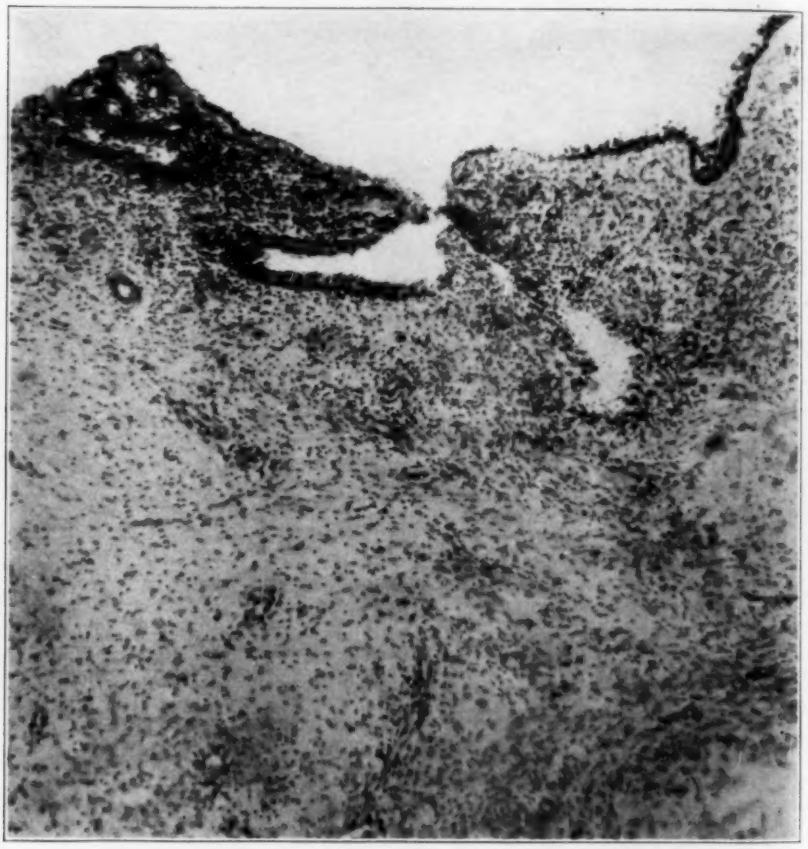

Fig. 2.—Photomicrograph of a section from the superficial surface of the reformed tissue eight months after the complete removal of the mucoperiosteum (× 80). The surface epithelium is generally pseudostratified, columnar and ciliated but in certain areas is nonciliated or cuboidal. The tunica propria is fibrotic. (No counteropening was made into the nose.)

rior turbinate, but a part of the bone from the naso-antral wall below the attachment of the inferior turbinate was removed in a manner similar to that used in the formation of a mucoperiosteal flap. (This area is referred to in the text as the

newly made membranous wall.) The latter procedure was undertaken as a precautionary measure, in the event that drainage should become necessary at a future time. A loose gauze drain, which was inserted into the sinus and brought out through the incision in the maxilla, was removed after twenty-four hours.

Two months later the maxillary sinus was reopened through the original incision. There was difficulty in retracting the soft tissues and the periosteum, because they were adherent to the mass of tissue which filled the sinus at the partly reformed

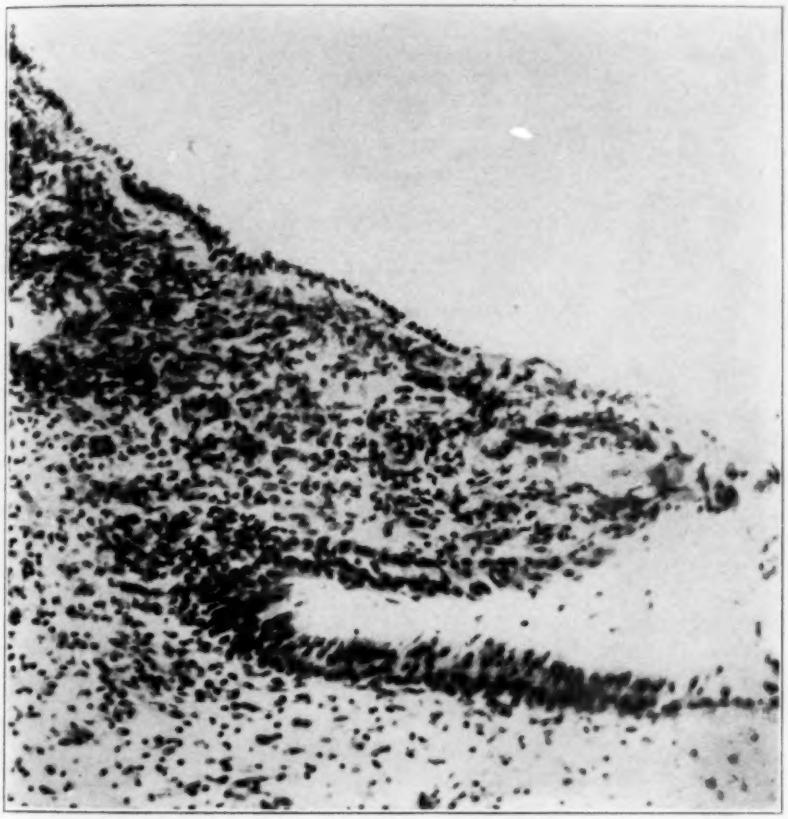

Fig. 3.—A higher magnification of fig. 2 (× 217), which demonstrates a single layer of cuboidal epithelium in proximity to a pseudostratified ciliated columnar layer eight months postoperatively.

anterior wall. The sinus was found to be extremely diminished. The newly formed tissue within the sinus was smooth, pale and firm and gave the feeling of hard rubber when a surface section was removed with a knife.

A study of the microscopic sections showed that the tissue consisted of mature connective tissue cells rich in fibrin (similar to a keloid) intermingled with bony deposits. No epithelium covered it. "Regeneration" of the mucosa did not take

place, because there was no epithelium or ducts of glands to promote it when the mucosa was completely removed, nor did epithelization take place by proliferation of the cells bordering the natural opening after two months. This was possibly due to a complete closure of the ostium.

From another patient a specimen was obtained with a punch forceps by incising the newly made membranous wall in the inferior meatus eight weeks postoperatively.

Fig. 4.—Photomicrograph of a section, showing the deposit of fibrous tissue which formed on the inner side of the mucosa of the naso-antral wall one year after the bone and the sinus mucosa were removed (× 164). A layer of cuboidal cells covers the new-formed tissue. The glands that are observed are part of the mucosa of the nasal surface. (No counteropening was made into the nose.)

In this operative instance the natural opening evidently remained patent. From a study of the microscopic sections (fig. 1) it was noted that a layer of stratified cuboidal and in some areas columnar epithelium covered the newly formed granulation tissue. No subepithelial glands were found.

From another patient a specimen was obtained eight months postoperatively. The newly made membranous wall offered great resistance to the penetrating instrument. The specimen which was obtained from the laterosuperior surface of the sinus showed a layer of columnar epithelium covering a dense layer of mature connective tissue. No evidence of the subepithelial structures found in normal mucosa was observed. The surface epithelium, however, was in many areas devoid of cilia (figs. 2 and 3).

In another patient a portion of the newly made membranous wall was removed for study one year postoperatively. It represented the intact mucosa of the lateral

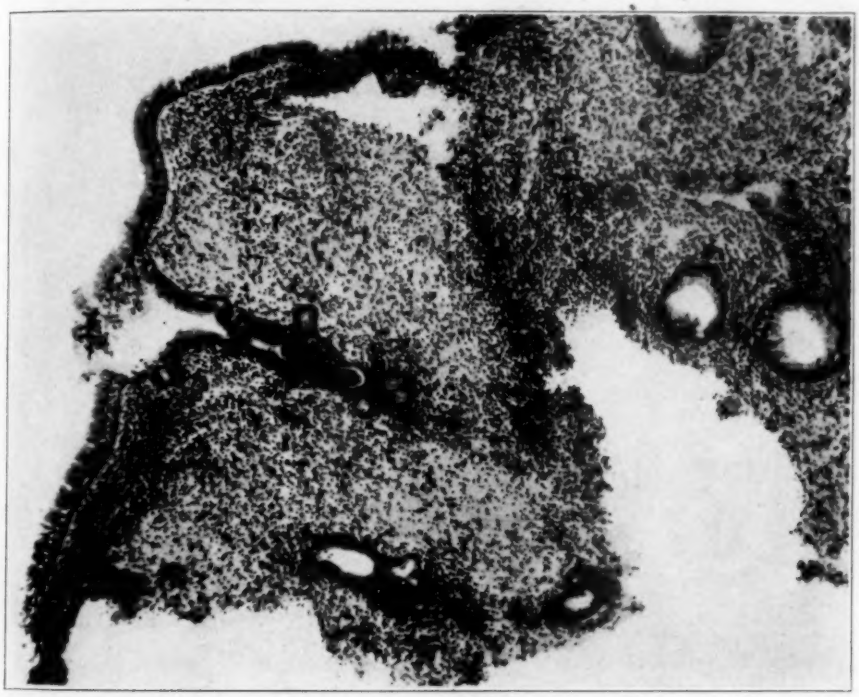

Fig. 5.—Photomicrograph of a section obtained from the surface of the reformed tissue eighteen months after the complete removal of the mucosa and the creation of a large counteropening (× 70). The surface epithelium shows a basement membrane closely resembling the epithelium lining the inferior meatus. Invaginations of the epithelium assume the appearance of pseudoglandular structures. The subepithelial tissues are extremely infiltrated with a variety of cells.

nasal wall below the inferior turbinate bone and the tissue which formed on it after the thin plate of bone and the sinus mucosa had been removed.

Although the periosteal layer became extremely thickened by the addition of mature fibrous tissue, it did not show any evidence of new bony formation. A layer of cuboidal cells was noted to cover some portions of this fibrous tissue. No. evidence of invagination of the epithelium or of gland formations was noted (fig. 4).

EXPERIMENT 2.—The following experiment was carried out to ascertain to what extent epithelization will occur after the usual Caldwell-Luc operation.

Both maxillary sinuses of a patient who had patent bilateral antrum windows were subjected to this procedure, because of an unrelieved purulent discharge from the nose.

Sections were obtained from the reformed tissue from each maxillary sinus eighteen months later by the use of a small punch through the opening in the naso-antral wall. It was noted from the study of the microscopic sections that the reformed epithelium was pseudostratified, columnar and ciliated. The sub-

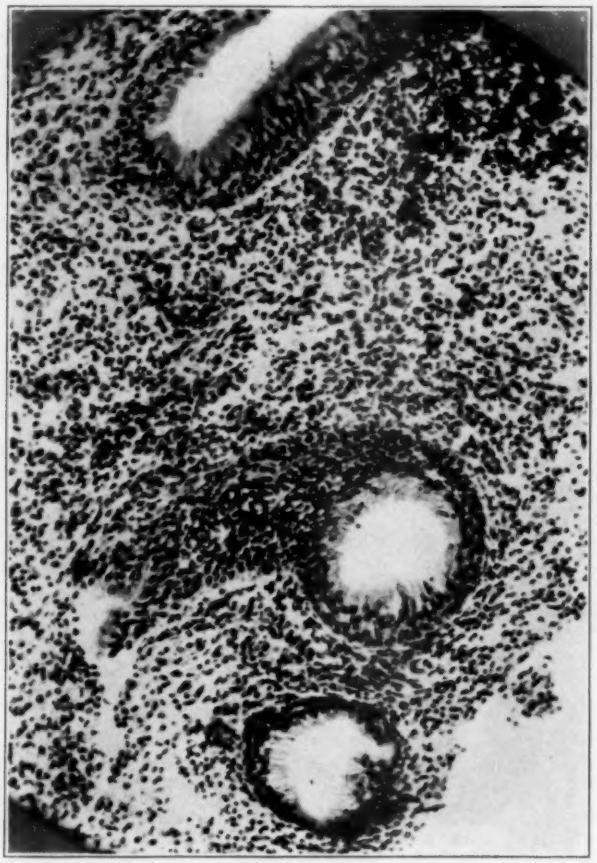

Fig. 6.—Photomicrograph of the same section shown in fig. 5; (× 138). The cells lining the pseudoglands in the center are similar to those of the surface epithelium as shown at the margin at the top of this figure.

epithelial tissue consisted of mature connective tissue, which was infiltrated mostly with lymphocytes, plasma cells and some polymorphonuclear leukocytes.

In several areas it could be noted that the epithelium dipped below its surface into the granulation tissue, giving it an appearance of gland formations. The length and the width of these glands and the persistency of the ciliated epithelium which lined them betrayed them as simple villiform invaginations (figs. 5 and 6).

EXPERIMENT 3.—Five weeks after the performance of the Caldwell-Luc operation on a maxillary sinus of a patient and the laying of a large flap of the nasoantral mucosa into the cavity the area was reopened. A biopsy specimen was taken from the reformed tissue, which evidently was a part of the original flap of nasal mucous membrane laid into the sinus at the time of the operation, because it showed an extreme abundance of glands and particles of old bone still adhering to the flap (fig. 7). Other sections showed granulation tissue.

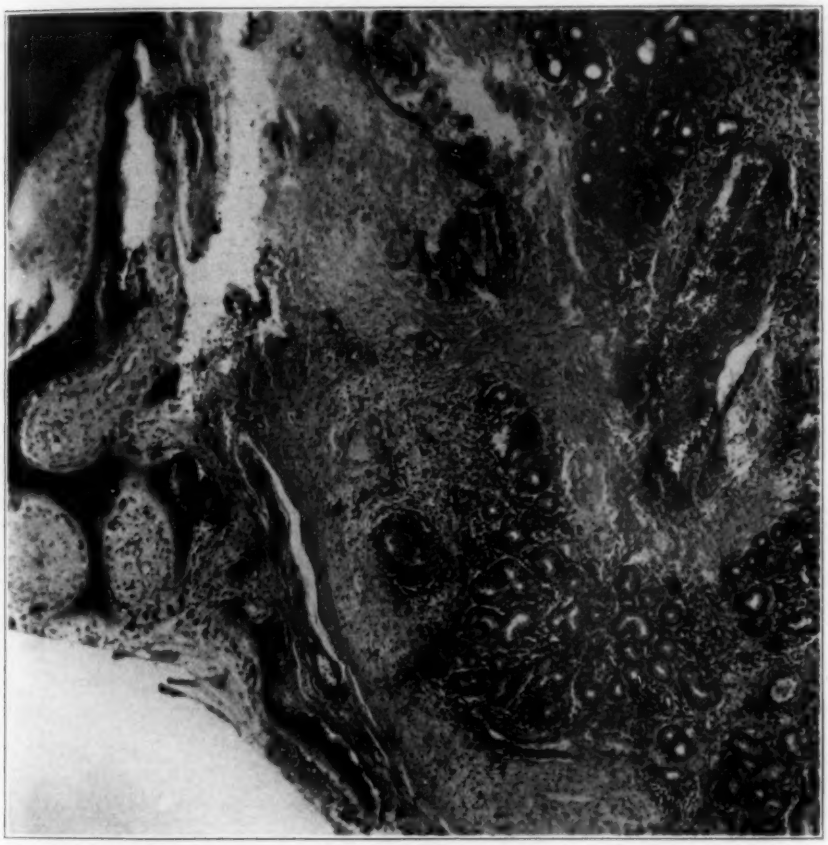

Fig. 7.—Photomicrograph of a section obtained after laying of a mucoperiosteal flap into the sinus (× 76). The large number of glands, blood vessels, cavernous spaces and particles of old bone prove that this tissue is part of the original mucosa of the nose.

COMMENT

In connection with the previously described modified operation on the maxillary sinuses of fifteen patients, I wish to state that the failure to provide a counteropening in the nose did not interfere with satisfactory end-results.

Theoretically, pseudostratified columnar ciliated epithelium is more resistant to the penetration of micro-organisms than other types of epithelium. A flap of mucous membrane or a large artificial opening from the sinus into the nose permits such epithelium to proliferate over the newly formed tissue within the sinus. From my experiments, however, I am more favorably impressed with the postoperative gross appearance and the microscopic sections of the sinus when no communications are established with the nose.

In no instance was a bare surface encountered postoperatively when examination was made directly or with the nasopharyngoscope. The cavities were reduced in size and presented a smooth pale surface free from discharge.

Various authors have stressed the difficulty of removal of the entire sinus mucosa. It is therefore important in undertaking an investigation of the postoperative repair to be certain that no vestige of the mucosa remains in the operative area. Otherwise, one's assertion that the subepithelial structures found at subsequent biopsy are new formations may be invalidated. This applies to the sections which are obtained after a flap of mucous membrane is laid into the sinus.

In comparing the results of experiments on animals with those on human beings, one must consider the difference in the reaction to trauma of a normal and of a diseased structure. Although in chronic sinusitis an extreme involvement of the blood supply and the cellular elements, which leads to an atrophic state, as described by me, or to osteomyelitis of the bone, is rare, mild involvement is common.

Mild involvement results either in localized areas of stimulation or in suppression of the bone-forming elements. Thus, in the postoperative repair there is a variation in the degree of the formation of new bone and fibrous tissue in the same cavity or in different subjects. A deposit of new bone and fibrous tissue which more or less obliterates the sinus takes place principally at the areas which are richly supplied with blood. These are at the furthermost points from the natural opening and in those parts where the spongy bone has been exposed or bared of its mucoperiosteum.

Some investigators have expressed the belief that the epithelial invaginations which have been observed at biopsy assume during the later stages of their development a true gland-secreting function. The late specimens which I studied show that those invaginations are in certain areas constricted off from the surface epithelium and hence have the appearance of pseudoglandular structures. There is a possibility that they may lead to the formation of cysts and to the accumulation of the discharge in the operative area. The invaginations of the epithelium occur more frequently in those cases in which a counteropening has

been made into the nose. When the epithelium proliferates over an even and firm surface of granulation tissue, invaginations or pseudogland formations usually do not occur.

Without attempting to take issue with the proponents of the theory of dedifferentiation of tissues in their process of repair, I may cite the following facts which are pertinent to the subject: It has long been known that where there has been complete loss of skin due to injury or necrosis, it is replaced by scar tissue which becomes covered with epithelium, while the sweat and the sebaceous glands and the hairs are not reformed. There are no gland structures in the epidermis which covers the healed cavity of the middle ear and the antrum following the radical mastoid operation.

SUMMARY AND CONCLUSIONS

Analysis of the reports of various investigators who have studied the postoperative repair of the paranasal sinuses shows their disagreement to be due either to the interpretation of the end-results in exceptional cases or to a too broad or a too narrow use of the term "regeneration."

In most animals it has been observed that after removal of the mucoperiosteum there is complete obliteration of the sinus. In the human being, however, the extent of obliteration depends on the size of the involved sinus, the health of the bone, the amount of accumulated blood in the sinus and the patency of the existing or of the established communication with the nose.

Usually the disease process of the mucosa does not affect the bone or affects it only slightly or not uniformly. In the postoperative repair there may be, therefore, a formation of a moderate or a large amount of granulation tissue of varying thickness in the same sinus, which is subsequently changed into bone and fibrous tissue. The latter replaces the periosteum, which was a part of the original mucoperiosteum.

The removal of the mucosa at a natural opening may result either in complete closure or in diminution of the opening. This prevents epithelization of the sinus through that source and further enhances the process of its obliteration. The latter condition, however, is counteracted when other communications with the nasal cavity are established.

Clinically, the reduction in the size of the sinuses has been demonstrated by reoperation, by probing the depths of the sinuses and by comparing the roentgenologic studies before the surgical operation with those of several months or years later.

Proliferation of the nasal epithelium takes place into the sinus by way of either the natural or the newly established opening or by the laying in of a mucoperiosteal flap. Epithelization, however, does not

take place synchronously with the repair of the other tissues. Invagination of the proliferating epithelium takes place in the early stages of repair, before the blood clot becomes organized into connective tissue or when it meets an uneven surface of scar tissue. The invaginations in most instances give the appearance of atypical glands. There is a possibility that these atypical glands contribute to the formation of postoperative cysts.

In most instances the newly formed tissue of the sinuses becomes covered with a layer of pseudostratified columnar ciliated epithelium, interspersed with goblet cells.

In exceptional instances the following features have been observed: a complete lack of epithelization, a partial covering of the operative area with pseudostratified ciliated columnar or cuboidal epithelium while other parts remained bare of epithelium and a covering of some areas with pseudostratified columnar ciliated epithelium and of the remainder with cuboidal epithelium.

All these histologic observations in their final clinical interpretation furnish a favorable prognosis.

Remnants of mucous membrane which are left in the sinuses accidentally or with the hope that they will unite with the newly formed epithelium or help to epithelize the sinus, may become completely covered over or be embodied in the scar tissue. They may cause no harm or may be a source of cyst formation and reinfection. Surgical procedures which consist of incomplete removal of the mucosa are therefore often subject to disappointment.

From the histologic studies one may deduce that after the complete removal of the mucoperiosteum in a case of uncomplicated sinus disease in which the procedure is indicated drainage, ventilation and epithelization of the operative area are of little importance in the attainment of satisfactory end-results.

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FALSE ANKYLOSIS OF THE MANDIBLE

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Limitation or absence of movement of the jaw may result from various causes and may be of short or long standing. It is seen in tetanus, in hysteria, in trigeminal neuralgia and as a reflex effect of pain from an inflammatory process in the mouth, the throat, the ear canal or the parotid gland. Impaction of or disease around a third molar tooth may cause spasm of the muscles of mastication, simulating a true ankylosis. It may be a result of injury or of suppuration in or about the joint and may occur in arthritis and in disease of the middle ear. It may be caused by an inflammatory mass, as in actinomycosis, by a tumor or by an ununited fracture. Other causes of this condition are severe infection of the oral cavity and postoperative reaction following one of the extensive surgical measures necessary in treatment of tumor of the mouth or of the jaw.

In true ankylosis there are permanent changes in the joint structures, while in false ankylosis there are changes in the neighboring soft tissues which limit motion.[1]

It may be difficult to differentiate between ankylosis produced by scar tissue and true bony ankylosis. Disability may be as great with either. There is a tendency for an ankylosis which at first is fibrous to become bony.[2]

If ankylosis occurs early in life, the mandible fails to develop properly and the chin remains small or markedly retracted. On the ankylosed side the face is full and round, while on the unaffected side it is flattened. The preangular mandible notch is deeper on the ankylosed side. Complete immobility of the affected joint is rare; even with bony fusion the teeth may be separated a few millimeters. As the mouth opens, the jaw deviates to the ankylosed side. This deviation is best determined by watching the midline between the central incisor teeth as the patient opens his mouth. Movement is slight or imperceptible on palpation over the affected joint. Roentgenograms should always be made. They may show an excess of bone and a complete loss

1. Blair, V. P., and Ivy, R. H.: Essentials of Oral Surgery, St. Louis, C. V. Mosby Company, 1923, pp. 372-392.

2. Blair, V. P.: Operative Treatment of Ankylosis of the Mandible, Surg., Gynec. & Obst. **14**:436-451 (Oct.) 1914.

of the outlines of the joint, and even though seldom clear enough for delineation of all structures, they may serve to demonstrate a foreign body, a fracture or an impacted tooth.

Treatment varies with the type of limitation and with the disease. For relief of acute ankylosis rest of the parts is usually desirable and is obtained by the use of a head and chin bandage or by the wiring together of an upper and a lower premolar tooth. Drainage may be required should suppuration occur. It may be necessary to extract a tooth, remove a foreign body or fixate a fractured bone. As the acute condition subsides, motion is again encouraged, to prevent a permanent ankylosis.

In a case of true ankylosis with fibrous or bony union of the joint structures, it may be possible to open the mouth by cutting periarticular bands. Usually, however, the condyle of the mandible must be resected. In this operation care is necessary to avoid the ocular branches of the facial nerve, the internal maxillary artery and part of the mandibular branch of the fifth nerve; care should be taken too that the jaw is not fractured and that sufficient bone is removed. Blair recommends blocking the jaw open afterward with a wood block to prevent contracture, which tends to occur quickly.

In a case of false ankylosis in which scar tissue is not excessive one may, by gradual dilation with hard rubber screws, clothes pins or some other simple appliance used regularly, overcome the fixation sufficiently to insert a spring appliance similar to that of Darcissac, in which the dilating force of heavy elastic bands counteracts the powerful elevator muscles of the mandible. This plan may require modification where teeth are loose or absent. By this means sufficient separation of the teeth is often obtainable in a few weeks. Should these measures be unavailing owing to the presence of excessive scar tissue, operation for division or removal of muscle or of fibrous tissue may be necessary. After such an operation, particularly if necessitated by the presence of scar tissue in the mouth, it may be necessary to cover raw surfaces with Thiersch or with full thickness skin grafts on a pedicle, thus preventing reforming and contracture of the scar.

REPORT OF A CASE

A girl aged 5 years was admitted to the hospital on July 3, 1937, because of inability to open her mouth. Her parents stated that at the age of 1 year the child had undergone elsewhere a mastoidectomy on the right side and that for two weeks afterward there had been a lump in front of the right ear. Medicine was applied to this swelling and soon the pus drained out, but the patient was unable to open her mouth. The ankylosis persisted, resulting particularly in difficulty in eating and in lack of physical development.

The child was small, her weight being only 30 pounds (13.6 Kg.). There was a large depressed scar over the right mastoid region. A medium low whisper was heard in the right ear. A small scar was present in the skin of the right preauricular region. The face was asymmetrical, the right cheek being fuller and rounder than the left. The mandible was not well developed; the chin receded.

In an attempt to open the mouth it was found possible to separate the incisor teeth only 5 mm., the right molar teeth 1 mm. and the left molar teeth 2 mm.; the jaw deviated to the right. The teeth appeared healthy and oral hygiene, good. On palpation over the right zygoma this process felt rough and irregular. No motion was detected by palpation in the region of the joint. Roentgenograms revealed a normal-appearing mastoid process and mandibular joint on the left. The right mastoid was small and infantile in type, and the few remaining cells were gray. There was an area of destruction about the antrum extending forward and downward to include the mandibular notch. The outlines of the right joint were not clear, and there was increase in density over the region of this joint.

A shows the appearance of the patient before operation; the teeth could be separated 5 mm. *B* shows the appearance of the patient six weeks after operation; the teeth could be separated 20 mm.

Urinalysis revealed a faint trace of albumin and a few pus cells, and on examination of the chest bronchial râles were heard. There was also slight fever. The patient was sent home and liberal feeding was advised. On her return to the hospital on July 13, operation was performed with general anesthesia. An inverted L-shaped incision was made anterior to the right ear, and the dense fibrous tissue over the joint was divided; then the mouth could be opened slightly over 2 cm. Spicules of bone were encountered in the tissue of the masseter muscle. The condyle was not resected. A mouth gag was placed in the patient's mouth, and the mouth was left open.

After the operation the mouth gag was kept in the mouth two or three hours each day. The patient was discharged from the hospital in good condition on July 16. Subequently the use of the mouth gag was continued daily for eight

days, an opening of 2 cm. between the biting surfaces of the incisor teeth being maintained. Then wooden tongue blades were substituted; in the ensuing month the number of blades inserted daily reached nine. At the present time the separation of 2 cm. is being maintained voluntarily. There has been an increase in the patient's weight to 35 pounds (15.9 Kg.). She gained 3½ pounds (1.6 Kg.) in the two weeks following surgical intervention.

It was impossible to make the definite diagnosis of fibrous or false ankylosis until the jaw was freed at operation. In this case it is possible that adequate after-care and observation following mastoidectomy would have resulted in better drainage of the preauricular abscess, prevention of the probable osteomyelitis of the joint and zygoma and prevention of ankylosis. Better nutrition and greater growth of the child would also have resulted. Although the danger of severe infection of the throat was always present, and although proper eruption of permanent teeth would have been difficult or impossible, it seems that under the handicap she did remarkably well for the four years of fixation of the jaw.

Clinical Notes

A NEW SPLINT FOR THE NASAL SEPTUM

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Any one who has had experience with an operation for the correction of a deformity or a fracture of the nasal septum can undoubtedly recall the unpleasant twenty-four hours following the operation. This was due, in a large measure if not entirely, to the bulky nasal packing used to approximate the septal flaps. While the packing was more or less successful in maintaining approximation, it

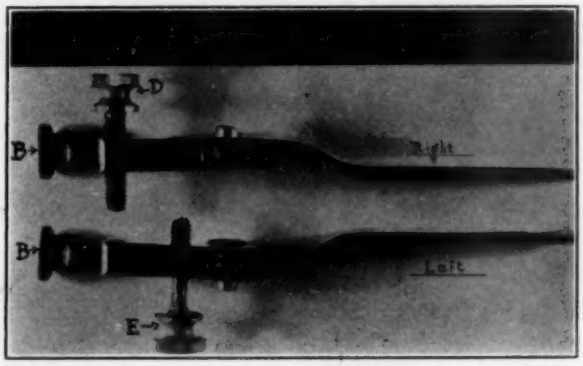

Fig. 1.—Top view of the apparatus, showing adjusting thumb screws.

occluded the nasal airway, dammed back nasal secretion, interfered with breathing and, in short, contributed materially to the general discomfort of the patient.

The instrument to be described has the following advantages: (1) maintenance of better mechanical approximation; (2) control of hemorrhage, especially postoperative hematoma; (3) maintenance of a free airway; (4) allowance of free drainage of nasal secretions, and (5) allowance of access to the nose for medication.

The instrument consists of a right and a left member (fig. 1). Each member has a body (fig. 2, *F*), one fixed blade (fig. 2, *A*) and four movable blades (fig. 2, *C*). The body carries two thumb screws; one (fig. 1, *B*) controls the movable blades, and the other (fig. 1, *D* or *E*) threads into the opposite member, bringing it into apposition with its fellow. The blades are so curved that when the two members are approximated there is sufficient clearance for the columella. The blades are made of spring-tempered phosphorus bronze of sufficient thickness to exert equal pressure along their entire length.

In use the blades are covered with a close-fitting rubber sleeve (narrow Penrose tubing), which not only acts as a protective covering but, by virtue of its elasticity, assists in returning the blades to the closed position for their with-

drawal. After completion of the submucous resection, the flaps of the nasal mucosa are placed in position. Then a gauze pad two or three layers thick, impregnated with paste of bismuth N. F. and cut to the size of the extended

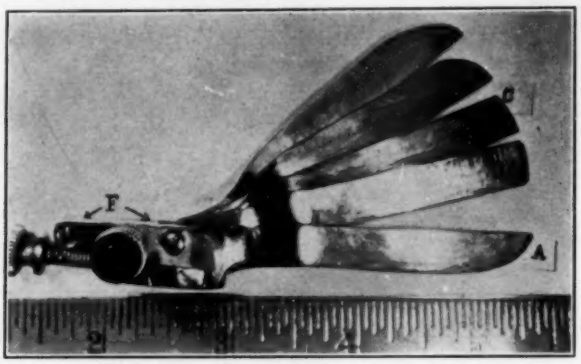

Fig. 2.—Side view, showing fixed and movable blades.

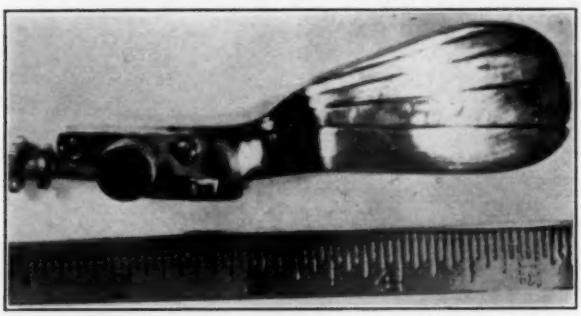

Fig. 3.—Side view of the left member, with the blades opened.

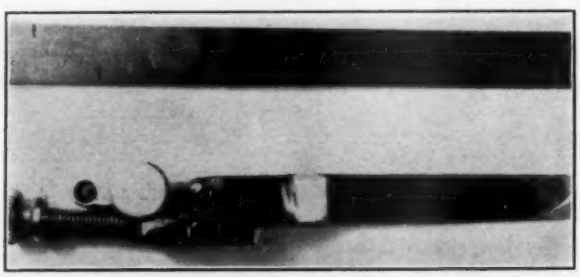

Fig. 4.—Side view of the left member, with the blades closed.

blades (fig. 3), is placed against each side of the septum. This pad forms an antiseptic and hemostatic cushion for the blades. As a rule, the member inserted first is on the side on which the incision has been made. The blades, enclosed in their rubber sheath and closed (fig. 4), are inserted along the floor of the nose until the curved portion of the member lies in a position to clear the

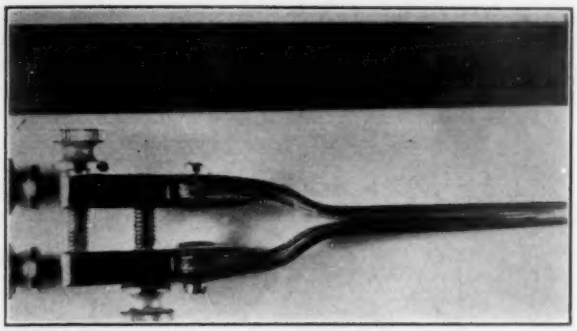

Fig. 5.—Top view of the splint, closed and assembled.

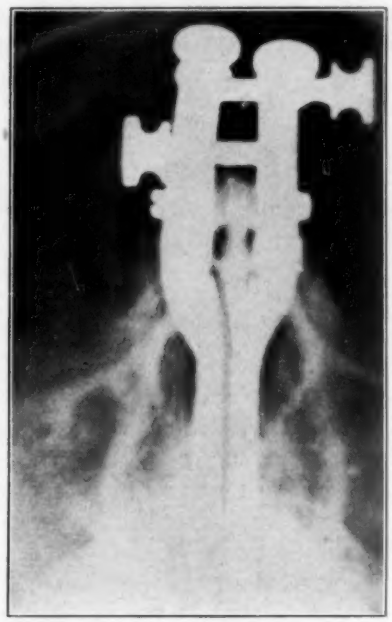

Fig. 6.—Roentgenogram of the splint in use (Watters position).

Fig. 7.—Lateral view of the splint in position.

columella. Then the thumb screw (fig. 1, *B*) is turned until the blades are opened in fan shape to an extent sufficient to cover the septum. The opposite member is then inserted and opened in a similar manner. The bodies of the members are then brought into apposition and fastened together by thumb screws (fig. 1, *D* and *E*). Thumb screw *E* (fig. 1) is unthreaded near its head, so that the amount of pressure exerted by the blades on the septum can be regulated without bringing the bodies of the two members closer together. The distance separating the two members is regulated by thumb screw *D* (fig. 1). This entire procedure takes but a few minutes. The splint, closed and in position, is shown in figures 5, 6 and 7.

In our series of cases there have been no unfavorable complications from the use of this instrument. Applications of isotonic ephedrine solution by spray at infrequent intervals after the operation have contributed considerably to the maintenance of a clear airway. At the same time it has been gratifying to note the greater comfort of the patient in the twenty-four hours following the operation.

174 Highland Avenue.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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PERORAL ENDOSCOPY

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DISEASES OF THE ESOPHAGUS

Congenital Malformations of the Esophagus.—The diagnosis of congenital lesions of the esophagus can now be made promptly and with precision. Bougienage and other inferential means of diagnosis have been replaced by roentgen esophagoscopic examination.

In a study of congenital deformities of the esophagus, Gerlings [1] found that the most common deformity is congenital atresia, either complicated or not with tracheoesophageal fistula. Atresia of the upper part of the esophagus with a tracheoesophageal fistula is the most frequent variety of this deformity. It is important from a diagnostic standpoint to know the various deformities which may occur with atresia.

Congenital stenosis of the esophagus is of more interest clinically, as the prognosis is good if a correct diagnosis is made and appropriate treatment is instituted. Symptoms commonly are not manifested until a child is given semisolid food. The nature and the location of the stenosis are determined by roentgen study; esophagoscopic examination, however, is indispensable for securing a more complete knowledge of the condition of the esophagus and for choosing a method of treatment. Congenital stenosis occurs in two forms, namely, that due to cylindric narrowing and that resulting from membranes. Narrowing commonly is observed at the site of a physiologic narrowing, particularly at the level of the tracheal bifurcation. These forms of stenosis are relatively rare.

A more common form of congenital stenosis is that usually referred to as congenital short esophagus. Gerlings reviewed the literature bearing on this subject and concluded that this appears to be a comparatively

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1. Gerlings, P. G.: Congenital Deformities of the Oesophagus: A Roentgenologic and Endoscopic Study, Acta pædiat. **19**:370, 1937.

frequent deformity. The esophagoscopic findings, usually characteristic, consisted of dilatation of the upper portion of the esophagus, with chronic esophagitis; a funnel-like or weblike stenosis of the lower, thoracic part of the esophagus, generally with ulceration which is superficial and covered with thin gray exudate; gastric mucosa immediately below the stenosis, and in some cases ulceration of the esophagus. Although this type of deformity is considered by some writers a separate form of hiatus hernia, Gerlings agreed with other observers that if one considers the genesis of hernia there is no question of any real hernia in this condition.

In many cases this deformity undoubtedly has been overlooked, owing to incomplete roentgen study and failure either to perform esophagoscopic examination or to inspect the food passageway beyond the stenosis. For an adequate roentgen study two factors must be observed: examination of the patient in the right-oblique-prone posture (described by Manges), which brings the hiatus oesophageus to a higher level than the remainder of the esophagus, and filling of the portion of the stomach below the diaphragm. On esophagoscopic examination one finds that the narrowing at the esophagogastric junction differs little from that present in recent organic stenosis. In certain of the reported cases the condition at first was considered cicatricial in origin, and its true nature was not discovered until the stenosis was traversed esophagoscopically and gastric mucosa found above the normal hiatal level.

The prognosis in these cases is good. Treatment consists of dilation of the stenosis.

According to Loza and Sabathié,[2] the presence of islands, or nodules, of gastric mucosa in the esophagus (rests from the primitive endodermal epithelial tube of the digestive canal) has constituted up to the present a subject of curiosity at postmortem examination. They said that Schaffer first described this anomaly and expressed the belief that cylindric cell carcinoma of the esophagus has its origin in these rests. In 2 patients examined by Loza and Sabathié the predominant symptom was moderate dysphagia for food. Other symptoms referable to the gastrointestinal tract were not present. At esophagoscopic examination in the first case a localized esophagitis was observed in the region of the nodule, near the lower end of the esophagus. In the other case the presence of rests did not seem to produce any appreciable esophageal trouble. It may therefore be concluded that the simple presence in the esophagus of a nodule of the type described by Schaffer can be perfectly tolerable and that such an anomaly of structure can undergo

2. Loza, M., and Sabathié, G.: Rests of Gastric Mucosa in Esophagus: Clinical, Pathological, Anatomic and Endoscopic Study, Bronchoscop., œsophagoscop. et gastroscop. **2**:125 (April) 1937.

alterations and can give rise to inflammatory changes which provoke additional trouble, more or less variable, at their site. The presence of a large obstructing nodule may produce difficulty in deglutition. This condition will explain the irritating action and the inflammation resulting from stoppage of food in its passage over the surface of the mucosa.

Neoplasms of the Esophagus.—Papilloma of the esophagus is observed infrequently. Hunt [3] expressed the belief that more frequent employment of esophagoscopic examination in cases of slight esophageal disturbances would reveal an increasing number of instances of benign tumor of the esophagus. He reported the case of a woman who had complained of gastric symptoms for thirty years. She had been taught to do stomach lavage and had carried out this procedure daily for twenty-two years. In addition, she had passed a bougie two or three times weekly, for dilation. When observed by Hunt she complained of symptoms referable to the esophagus and the stomach. There was slight roentgen evidence of retention at the cardia. At esophagoscopic examination ulceration of the lower part of the esophagus, some varicosities and a moderately tight cardia were found. Biopsy did not show cancer. Five years later esophagoscopic examination revealed multiple small tumors below the cricopharyngeus muscle and above the cardia. Biopsy was done, and a diagnosis of papilloma was made. This case is of interest because of the daily trauma over a period of thirty years, its possible influence on the origin of the papilloma at the lower end of the esophagus and the probability of transplantation of tumor at the upper end of the esophagus by the daily passing of a tube.

Carcinoma of the Esophagus.—Zinn [4] reviewed the clinical and diagnostic aspects of esophageal carcinoma and emphasized certain important points. Cancer of the esophagus is not an uncommon disease, though it is less frequently found than is cancer of the stomach. The disease is more common in males than in females. It usually appears during the middle years of life, and later in males than in females. The site is most apt to be at one of the physiologically narrow portions of the lumen, owing probably to greater irritation produced at these areas by the passage of food. The most common types of carcinoma found are squamous cell epithelioma and adenocarcinoma. Together they represent 90 per cent of the tumors of the esophagus. Early symptoms are vague and indefinite, and diagnosis is therefore delayed. Roentgen and esophagoscopic examination, possibly with biopsy, are essential for conclusive proof of the presence of the disease. The necessity of early diagnosis cannot be too strongly stressed. A

3. Hunt, W. M.: Multiple Papilloma of the Esophagus: Case Report, Ann. Otol., Rhin. & Laryng. **46**:752 (Sept.) 1937.

4. Zinn, W. F.: Cancer of the Esophagus, South. M. J. **30**:567 (June) 1937.

change in teaching methods would aid in realizing this need. Radical surgical intervention can and should be attempted in cases in which diagnosis has been made early and the patient is free from other physical disorders.

Can the diagnosis of carcinoma of the esophagus be established consistently in an early stage? Decker [5] expressed the opinion that it cannot, since subjective symptoms in the early stages of the disease are either trivial or absent. Dysphagia is the only symptom which calls attention to a disturbance of esophageal function and for which the patient will consult a physician. Well defined dysphagia means that there is an obstructing lesion. While the diagnosis of early cancer can be made positively by esophagoscopic examination and biopsy, the opportunity to examine the patient during the early stage is rarely afforded.

The discouraging results in the treatment of carcinoma of the esophagus are due in part to failure to make an early diagnosis. In a case reported by Moersch [6] the disease was in a relatively early stage of development, and an excellent result was secured by the employment of surgical diathermy. The growth, a polypoid tumor, appeared to originate from the right wall of the esophagus in the upper third and almost completely filled the lumen. The diagnosis, based on biopsy, was squamous cell carcinoma, grade 2 (Broder's classification). In view of the patient's age (68), the type of growth and the location of the growth in relation to the arch of the aorta, it seemed that an attempt to destroy the tumor by means of surgical diathermy was justifiable. This procedure was carried out esophagoscopically, with relatively little discomfort to the patient and with slight postoperative reaction. One month later roentgenoscopic study revealed a normal esophagus. At esophagoscopic examination three small areas of infiltration were observed at the original site of the lesion. These were readily destroyed by coagulation.

Foreign Body in the Esophagus.—The series of cases involving 250 foreign bodies reported by Witkowsky [7] represents an experience of fifteen years. These cases differ from those usually reported in that a large number of the patients suffered from cicatricial stenosis of the esophagus. Cicatricial stenosis due to the ingestion of a caustic material is common among the Slavs. Articles of food constituted a majority

5. Decker, H. R.: The Diagnosis and Treatment of Carcinoma of the Esophagus, Pennsylvania M. J. **40**:1038 (Sept.) 1937.

6. Moersch, H. J.: Treatment of Carcinoma of the Esophagus by Means of Surgical Diathermy, J. Thoracic Surg. **7**:42 (Oct.) 1937.

7. Witkowsky, B.: Statistics on a Series of Two Hundred and Fifty Foreign Bodies in the Esophagus, Bronchoscop., œsophagoscop. et gastroscop. **1**:78 (Jan.) 1937.

(173) of the foreign bodies. Of these, about 50 per cent consisted of bones or of pieces of cartilage. It is of interest to note that articles of food as foreign bodies were observed infrequently in children. In 53 of 64 children the foreign body was a coin, a button or some other object used as a toy.

During a practice extending over a period of thirty years, Pouget [8] observed 150 cases of foreign body in the esophagus. The youngest patient was an infant aged 11 days, with a brooch in the esophagus; the oldest was a man aged 85, with a bone in the esophagus. Sixty-five bones and 34 coins accounted for practically two thirds of all foreign bodies. Although there were 12 dentures in the group of objects removed, Pouget had observed many patients who had swallowed small dentures which had passed spontaneously. The wretched condition of the teeth of the people of the author's district (Angoulême, France) and the frequency with which dentures are worn may be in part responsible for the frequency of accidents involving a foreign body. It is not uncommon to find a person in the early thirties wearing a complete denture. A denture was removed from the esophagus of a boy aged 18.

Tucker [9] reported his observations on a series of 11 cases of jackstone in the esophagus. In 10 of these the ages of the patients varied from 21 months to 6 years. Detailed case reports are included in the article. Tucker concluded that a jackstone is potentially a dangerous foreign body when lodged in the esophagus. Owing to its irregular shape, this object tends to embed its points in the tissues, making removal without trauma a difficult problem. Serious trauma in most cases is due to hasty and ill advised attempts at removal. Urgent dyspnea is the only indication for immediate operative intervention, and it should be relieved by tracheotomy. The jackstone can be removed with safety after the tracheotomy wound is well sealed off. Dyspnea may occur during an attempt at removal. This necessitates temporary discontinuance of efforts at removal, and withdrawal of the esophagoscope. The safest method of removal is the dangling method of Jackson. With this procedure it is important that the endoscopic tube used be equal in diameter to the greatest diameter of the jackstone. The diameter of the jackstone may be determined by roentgen examination and the matching of a duplicate foreign body. Roentgen guidance during removal may be of value in some cases. The presence of unilateral

8. Pouget, R. J.: Discussion of One Hundred and Fifty Cases of Foreign Bodies in the Esophagus, Bronchoscop., œsophagoscop. et gastroscop. **1**:38 (Jan.) 1937.

9. Tucker, G.: Jackstones in the Upper Food Passages: Reports with Esophagoscopic Observations on Eleven Cases, Ann. Otol., Rhin. & Laryng. **46**:237 (March) 1937.

pneumothorax may be a temporary contraindication to the removal of the jackstone from the esophagus. After the pleural lesion is under control the foreign body may be removed esophagoscopically without danger of bilateral pneumothorax.

GASTROSCOPY

An enormous amount of literature on the use of the flexible gastroscope in the diagnosis and management of various gastric disorders has appeared during the past year. No attempt is made to include here all the articles or to provide a complete abstract. A brief summary of the subject matter is given and the references noted.

Taylor [10] discussed the history of gastroscopy and the technic of gastroscopic examination and treatment and described the endoscopic appearance of the normal stomach. He analyzed 60 cases in which gastroscopic examination was definitely indicated and was employed and discussed in detail certain cases selected from this group. The tabulated list of results in the entire 60 cases is worthy of study. The author set forth the findings by roentgen study, the results of gastroscopic examination, the reactions to a test meal and the final diagnosis. The article is enhanced by excellent colored drawings of endoscopic views.

In discussing the methods of gastroscopic examination, Freeman [11] expressed the opinion that the flexible gastroscope offers the best possible means of inspecting the interior of the stomach. He discussed the influence of peristalsis on the gastroscopic appearance, emphasized certain phases of the technic and discussed and described the forms of chronic gastritis. He stated that gastric hemorrhage is a definite indication for gastroscopic examination, particularly when the usual routine examinations fail to reveal the source of bleeding. He mentioned, however, that it is important to rule out disease of the esophagus before attempting to pass the flexible gastroscope.

In reporting his experiences with gastroscopic examination, Horan [12] stated that the examination can be carried out with safety and with little discomfort to the patient. It does not replace roentgen study. The use of both procedures is essential for the complete investigation of gastric disorders. This method of examination allows the clinician to follow the progress of a benign disorder and to observe the response to treatment of a gastric ulcer. The benign or malignant nature of the gastric ulcer can often be determined by use of the gastroscope. The instrument enables one to determine the situation of a gastric neoplasm

10. Taylor, H.: Gastroscopy: Its History, Technic and Clinical Value with Report on Sixty Cases, Brit. J. Surg. **24**:469 (Jan.) 1937.

11. Freeman, E. B.: Gastroscopy as a Diagnostic Procedure, Am. J. Digest. Dis. & Nutrition **4**:312 (July) 1937.

12. Horan, J.: Gastroscopy, M. J. Australia **2**:243 (Aug. 14) 1937.

and the amount of the wall of the stomach involved by it. Its use is of great importance in determining the possibility of resection in a case of carcinoma of the stomach. Gastroscopic examination often discloses the cause of a condition which develops in a patient who has been operated on for a gastric disease. Horan stated that he considered the gastroscope indispensable in the management of gastric disorders.

In a study of diseases of the stomach, Schloss and his associates [13] emphasized the importance of both roentgen relief technic and gastroscopic examination as representing a decided improvement over the previous routine in diagnosis. They reported a study of 100 cases. They stated that gastroscopic examination is far superior to roentgen relief technic for the diagnosis of gastritis. Gastroscopic examination is the only method by which erosion or atrophy of the gastric mucosa can be diagnosed. In their study gastric ulcer was observed more often by gastroscopic than by roentgen examination. For the diagnosis of gastric tumor and of postoperative changes in the stomach the roentgen relief method and gastroscopic examination supplement one another in an ideal manner.

Although the diagnosis of chronic nonspecific gastritis was obsolete for many years, recent studies have shown that the condition is a common gastric disorder. In the gastroscopic examination of more than 2,500 patients, all of whom had abdominal complaints, Schindler and his associates [14] found that but 23 per cent had a normal stomach. Fifty per cent exhibited evidences of "superficial gastritis." In subsequent gastroscopic examinations a change was observed in some patients of this group. The mucosa appeared thin and greenish gray, and protruding blood vessels were seen. "Atrophic gastritis" had developed.

A third form of the disease, a separate and distinct clinical entity, is "hypertrophic gastritis." This form is typified by failure of the mucosa to revert to normal and by sudden recurrence of symptoms even while the patient is under careful management.

A fourth form of chronic gastritis is that of the "postoperative stomach." All three of the forms mentioned, namely, superficial, atrophic and hypertrophic gastritis, occur combined. This condition offers the worst prognosis.

In a summary of their study the writers expressed the opinion that chronic gastritis looms as a major problem in internal medicine. It is a frequent and often a severe disease. It occurs with many other dis-

13. Schloss, J.; Ettinger, A., and Pratt, J. H.: Diagnosis of Diseases of the Stomach by Gastroscopic and X-Ray Relief Studies, Am. J. M. Sc. **193**:171 (Feb.) 1937.

14. Schindler, R.; Ortmayer, M., and Renshaw, F. J.: Chronic Gastritis, J. A. M. A. **108**:465 (Feb. 5) 1937.

eases. The symptoms are not absolutely characteristic. Physical examination, gastric analysis and roentgenograms are of little aid in making the diagnosis. Examination with the flexible gastroscope, which is safe and easy and causes little discomfort, is the only method permitting accurate diagnosis. It enables one to treat the patient according to the morphologic indications and possibly to avoid such dangerous consequences as cancer of the stomach.

Chevallier and Moutier [15] found gastroscopic examination an invaluable aid in the diagnosis of anemias. They agreed with Schindler and his associates with regard to its use in discovering new lesions. A color relationship exists between certain changes in the blood and alterations in the gastric mucosa. These changes are distinctly different in hypochromic anemia and in the anemias of the pernicious type. Whereas in hypochromic anemia one finds only slight diffuse atrophy, in the pernicious anemias the atrophy is more marked and more generalized and pearly plaques can be seen. These changes are so clear that if one makes a gastroscopic examination on a subject presenting any digestive disturbances, it supplements other examinations in detecting associated diseases of the blood. Gastroscopic examination enables one to determine the alteration of the gastric lesions associated with the anemias, by demonstrating the initial step. Gastroscopic examination shows that repair of the mucous membrane is possible; the alteration of the blood picture and the repair of the mucous membrane go hand in hand. While the hemogram of a patient with pernicious anemia shows hyperchromia in the beginning, hypochromia frequently develops under the influence of liver therapy. One sees the mucous membrane lose its pearly color, and the atrophy becomes that of the common type seen in hypochromic anemia. Study of the mucosa allows one to see a veritable rebirth of the epithelium and a re-formation of villi. The re-formation of the villi is clearly shown by small red dots, like the tip of a gloved finger, seen at repeated intervals. These dots must represent tortuous and dilated capillaries in the newly formed villi.

Endoscopic examination also allows one to give a prognosis on the degree of repair of the mucosa, regardless of the apparent general condition of the patient. Gastroscopic examination is helpful in diagnosing other diseases of the blood. It allowed the authors to discover an autonomic gastric purpura. Gastroscopic studies carried out simultaneously with hemologic studies permitted the fitting of the condition of the stomach into the general pathologic changes of the anemias. These studies suggest that, in spite of the importance of the stomach in pathologic changes in diseases of the blood, the condition of the

15. Chevallier, P., and Moutier, F.: Gastroscopy in Diseases of the Blood, Sang **11**:935 (Dec.) 1937.

stomach is not the cause of certain of these diseases; rather, the stomach is affected to the same extent as the blood by a general morbid factor.

From 400 gastroscopic examinations made on patients with gastrointestinal symptoms, Morrison and his associates [16] found a number of patients who had hypochromic anemia and achlorhydria. These patients exhibited definite gastroscopic evidence of atrophic gastritis. In the opinion of the authors, idiopathic hypochromic anemia is the partial expression of a syndrome, not a disease entity; it is a metabolic disturbance as yet unidentified. This syndrome may be an etiologic factor in the genesis of pernicious anemia, subacute combined degeneration of the spinal cord and carcinoma of the stomach and esophagus. The authors presented observations made in 11 cases.

Baumel [17] said that the gastroscope permits a study of the anatomic lesions present in living patients. He pointed out that one should always consider gastric catarrh and hypertrophic and atrophic gastritis in diagnosis. He discussed gastritis, ulcer of the stomach, gastric diverticula and carcinoma of the stomach. He observed that the type of tumor, whether benign or malignant, can be determined by familiarity with gastroscopic views. Gastroscopic examination of the stomach has become an easy and not a dangerous procedure. It is important that the gastroscopist familiarize himself with the normal gastric appearances so that he may interpret abnormal findings. Baumel stated that in his experience gastroscopic examination is becoming more and more valuable in gastroenterologic work and soon will be employed as frequently as roentgen examination.

Although it has long been recognized that hemorrhage may occur with gastritis, the more general employment of gastroscopic examination in cases of this condition has revealed that gastritis is an important cause of gastric bleeding. Benedict [18] used the gastroscope in a study of 20 cases of acute or chronic gastritis associated with hemorrhage. The only demonstrable and the most probable source of bleeding in these cases was the superficial or hypertrophic gastritis present, often with one or more erosions in the gastric mucosa. An important etiologic factor in massive bleeding from gastritis is the excessive use of alcohol. In Benedict's opinion a varying degree of bleeding from chronic superficial or hypertrophic gastritis may occur in the absence of other

16. Morrison, L. M.; Swalm, W. C., and Jackson, C. L.: Syndrome of Hypochromic Anemia, Achlorhydria and Atrophic Gastritis: Gastroscopic Studies with Case Reports, J. A. M. A. **109**:108 (July 10) 1937.

17. Baumel, J.: The Gastroscope in Gastric Pathology, Gastritis, Ulcers, Diverticulum, Cancer and Benign Tumors, Bronchoscop., œsophagoscop. et gastroscop. **2**:105 (April) 1937.

18. Benedict, E. B.: Hemorrhage from Gastritis: A Gastroscopic Study, Am. J. Digest. Dis. & Nutrition **4**:657 (Dec.) 1937.

demonstrable changes in the gastrointestinal tract. Gastroscopic examination is indispensable for the accurate diagnosis of gastritis and the recognition of erosions.

Conditions that give rise to a recurrence of symptoms after operative procedures commonly performed for the relief of gastric or duodenal ulcer or the removal of carcinoma now may be investigated by use of the flexible gastroscope, to determine their exact nature. Carey [19] examined gastroscopically a group of 15 patients previously operated on for gastric disorders who had a recurrence of symptoms. In all cases he found some condition to explain the complaints or the abnormalities observed by roentgen examination. Attention was directed to the rather frequent occurrence of gastritis and to the existence of several types of gastritis in the same stomach.

He concluded that gastroscopy offers the only means of observing directly such changes in the gastric mucosa as are likely to result from a poorly functioning opening placed in the stomach as part of some operative procedure. These changes include various types and degrees of gastritis and ulceration and recurrence of a malignant process. Because of the similarity between the symptoms and often the roentgen findings of peptic ulcer and those of chronic hypertrophic gastritis, Carey suggested that gastroscopic examination should always be made before operation in cases of these conditions.

DISEASES OF THE LARYNX

Patterson [20] pointed out that the history is of importance in the diagnosis of laryngeal disease in children. He also directed attention to the anatomic character of the child's larynx and to the influence of inflammatory swelling, infection and trauma in the rapid development of symptoms associated with an acute stenotic lesion. Inferential diagnosis of laryngeal disease in children is dangerous. Differential diagnosis should be made by direct laryngoscopic examination with the assistance of roentgen and laboratory examination. The larynx of any child, even that of a newborn infant, can be examined by the direct method.

Papilloma of the Larynx.—In reviewing the literature on papilloma of the larynx, Foster [21] was impressed with the variety of methods of treatment employed. He reviewed the results of treatment in a personal series of 11 cases. Nine of the patients were very young children who had received no previous treatment. These children were given a

19. Carey, J. B.: Gastroscopic Observations of the Postoperative Stomach, Surg., Gynec. & Obst. **65**:447 (Oct.) 1937.

20. Patterson, E. J.: Laryngeal Symptoms in Children, Pennsylvania M. J. **40**:257 (Jan.) 1937.

21. Foster, J. H.: Treatment of Laryngeal Papillomatosis, Ann. Otol., Rhin. & Laryng. **46**:786 (Sept.) 1937.

course of radiation therapy, with the result that in 8 the condition cleared up promptly, without recurrence up to the time Foster wrote. He expressed the opinion that most, if not all, primary papillomas in children are amenable to low voltage, mild radiotherapy. He stated that he had observed no good effects from the use of radiotherapy in the treatment of papilloma in adults.

A case of retention cyst of the larynx reported by Equen [22] is of interest because of the point of attachment of the tumor and the intermittent occurrence of symptoms. Under emotional stress the patient, previously possessed of a normal voice, would suddenly become aphonic and dyspneic. On taking a swallow of water he would have a sensation of swallowing a firm mass and would then be relieved of symptoms. Examination with the mirror laryngoscope showed a normal larynx. With the direct laryngoscope a freely movable pink mass was observed in the laryngopharynx. It was attached by a thin pedicle to the posterior surface of the cricoid cartilage. Removal of the tumor resulted in complete recovery.

DISEASES OF THE TRACHEA AND THE BRONCHI

Anatomic Considerations.—In a study of pulmonary disease with regard to bronchopulmonary segments, Neil, Gilmour and Gwynne [23] found that ordinary bronchographic examination has not materially refined the conceptions of bronchial anatomy. An intelligent bronchoscopic survey of bronchopulmonary diseases, as well as their accurate localization by roentgen rays, depends on accurate knowledge of the general orientation of the bronchial system, the relation of the individual bronchi to the main stem and to one another, the area of lung served by each bronchus and the surface markings and roentgenographic projections of these areas on the wall of the chest.

This study of the bronchial system is based on a survey of available literature, dissection of pulmonary segments treated with solution of formaldehyde, construction of fusible metal casts of the tracheobronchial system and plaster casts of the lungs, bronchoscopic examinations and the filling of single bronchopulmonary segments with iodized oil through the bronchoscope for roentgenographic study by posteroanterior, lateral and stereoscopic exposure.

The writers recognized in the lower lobe apical, mesial, anterolateral, posterolateral and paravertebral bronchopulmonary segments. A par-

22. Equen, M.: Retention Cyst of the Larynx: Report of a Case, Ann. Otol., Rhin. & Laryng. **46**:757 (Sept.) 1937.

23. Neil, J. H.; Gilmour, W., and Gwynne, F. J.: The Broncho-Pulmonary Segments: Radiological, Pathological and Bronchoscopic Considerations, with Special Reference to the Subapical Broncho-Pulmonary Segment, M. J. Australia **2**:165 (July 31) 1937.

ticular investigation was made of the lesser orifices on the dorsal and mesial aspects of the lower part of the main stem bronchus. These lie between the apical bronchus and the final bifurcation of the stem into posterolateral and paravertebral bronchi. They were designated subapical.

The posterior region of the lower lobe is supplied, according to all previous publications to which Neil and his associates had access, by the apical bronchus in the upper portion and by the paravertebral bronchus in the lower. The authors stated the conviction that an intermediate, separate segment exists and can be demonstrated and that it is the site of localized pathologic change, as shown by roentgen and bronchoscopic examination. It is an anatomic gap in the distribution between the apical and the paravertebral bronchi according to all illustrations available. They found that it is supplied by these subapical bronchi. This was shown by inflation in specimens and by filling segments with iodized oil in patients.

If the distribution of the bronchi as outlined is applied to satisfactorily exposed roentgenograms (especially stereoscopic), it will be found that it corresponds more or less accurately with the pulmonary markings. By using these findings Neil and his associates were able to survey all the bronchopulmonary segments seriatim during the routine examination of their ordinary films.

Untoward Effects of Local Anesthesia.—The occurrence of untoward effects after the employment of cocaine in connection with use of the bronchoscope is of interest to bronchoscopists. This drug is commonly employed with adults for the induction of surface anesthesia, by topical application in the form of a spray or of drops in the pharynx or by instillation or topical application in the larynx and the trachea.

Jones [24] reported the occurrence of a fatality in the case of a woman aged 26. Bronchoscopic examination was performed for diagnosis of obscure hemoptysis; the findings were negative. Iodized oil was instilled bronchoscopically on three occasions within about five weeks of the original use of the bronchoscope. The instrument was used a fifth time seven weeks later for instillation of iodized oil. A preliminary hypodermic injection of ¼ grain (0.015 Gm.) of morphine sulfate was given, followed by two sprayings of a 10 per cent solution of cocaine hydrochloride to the throat and later the spraying of 2 cc. of a 4 per cent solution into the trachea and the bronchi. Five cubic centimeters of iodized oil were then instilled into each lung, and the patient was transferred to the roentgen ray department. She had a general convulsive

24. Jones, D. H.: Cocaine Sensitivity in Bronchoscopy: Case Report, Ann. Otol., Rhin. & Laryng. **46**:749 (Sept.) 1937.

seizure, two minutes later a second seizure and following that two more. All efforts at resuscitation were unsuccessful.

At autopsy chronic leptomeningitis with generalized visceral congestion was observed. Chemical examination of the viscera did not show cocaine.

In a second case twitching of the right side of the face and clonic movements of the right arm followed by general convulsion of the entire body, lasting for three or four minutes, occurred during a diagnostic bronchoscopic examination performed with cocaine anesthesia. In this case preliminary sedation by means of amytal, morphine sulfate and hyoscine hydrobromide was followed by spraying of a 10 per cent solution of cocaine hydrochloride into the bronchi. The patient regained consciousness and recovered.

Use of the Bronchoscope for Diagnosis.—The similarity of the results of physical and roentgen examination of the chest in cases of acute laryngotracheobronchitis to those in cases of foreign body in an air passage led Gatewood [25] to make a provisional diagnosis of foreign body in 2 of the 6 cases reported by him. In 1 there was atelectasis of the right lung indicative of bronchial obstruction. At bronchoscopic examination swelling and infiltration of the mucous membrane with obstruction of the right bronchus with thick secretion were found. The patient, a child, made a complete recovery after repeated aspirations.

In a discussion of pulmonary diseases of infancy and early childhood, Hart [26] presented the subject from the standpoint of the bronchoscopist. He reported clinical cases under the following heads: congenital defects; primary bronchial diphtheria; suppurative pneumonitis, acute or chronic, without or with cavity formation, and bronchiectasis secondary to neglected foreign body. He cited illustrative cases under the various headings. The presentation was made to correlate the subject as a whole under one heading for physicians interested in this question and to show the vast possibilities of diagnostic and therapeutic use of the bronchoscope and the safety of its use under properly controlled conditions.

In a general discussion of the importance of bronchoscopic examination in diagnosis of diseases of the chest, Buckles [27] expressed the opinion that the bronchoscopist should be familiar with diseases of the chest and that the internist should be capable of thinking clearly in terms

25. Gatewood, E. T.: Bronchoscopic Observations of Laryngo-Tracheobronchitis in Children with Obstructive Dyspnea, Virginia M. Monthly **63**:600 (Jan.) 1937.

26. Hart, V. K.: Pulmonary Pathologic Conditions in Infancy and in Childhood, Am. J. Dis. Child. **53**:1544 (June) 1937.

27. Buckles, M. G.: The Necessity of the Bronchoscope in Modern Chest Work, Am. Rev. Tuberc. **35**:581 (April) 1937.

of bronchoscopy. Bronchoscopic examination should be considered a definite adjunct in diagnosis of disorders of the chest, for it permits one to observe during the patient's life pathologic processes and associated mechanisms of the tracheobronchial tree.

Use of the bronchoscope has a definite place in work with tuberculosis; in fact, the number of indications for its use are greater now than was previously supposed. The presence of bronchial obstruction is almost always an indication for bronchoscopic examination. In many cases it is necessary to rule out bronchiectasis.

Hemoptysis.—The significance of hemoptysis as a sign of serious pulmonary disease has been long recognized. It has been assumed generally that hemoptysis in a large proportion of cases is caused by pulmonary tuberculosis. Now that more careful study of the tracheobronchial tree has been made, it is recognized that the causes of hemoptysis are many and varied. McGibbon and Baker-Bates [28] described 6 cases of hemoptysis of unknown origin. The lesion causing the hemorrhage was found to be tracheal varix, simple bronchial granuloma or an innocent or malignant new growth. In the opinion of the authors, bronchoscopic examination, a safe and harmless method of investigation, affords the only possible means of making an early and correct diagnosis in such cases. It is particularly important in cases of malignant bronchial neoplasm, since waiting to establish a diagnosis allows the hope of curative therapy to pass.

Pulmonary Atelectasis.—Experiments were performed by Galbraith and Steinberg [29] to investigate the work of other observers on the relation of bronchial obstruction to pulmonary atelectasis. Dogs were employed as subjects. All procedures were carried out under pentobarbital sodium anesthesia. The obstructing material, consisting of rubber bath sponge, was introduced bronchoscopically. The dogs were killed at intervals of from thirty minutes to thirteen days after the bronchi were obstructed. Frequent roentgenographic observations were made on living dogs; the pulmonary circulation and in some animals the bronchial circulation were visualized by the injection of iodized oil; microscopic study was made of tissue removed from the obstructed lung and from the plugged bronchi and from the normal lung and the normal bronchi. The gradual changes observed grossly, microscopically and roentgenographically were recorded.

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28. McGibbon, J. E. G., and Baker-Bates, E. T.: Direct Bronchoscopic Investigation in Haemoptysis Without Physical or Radiological Manifestations, Brit. M. J. **1**:109 (Jan. 16) 1937.

29. Galbraith, E. G., and Steinberg, B.: The Developmental Mechanism of Pulmonary Atelectasis, Ann. Otol., Rhin. & Laryng. **46**:800 (Sept.) 1937.

In a study of the results of these experiments carried out on a series of 30 dogs, the writers arrived at the following conclusions: Pulmonary atelectasis can be produced under the conditions present in (?) their experiments by serious interference with respiratory movements (inflation and deflation of the lungs). Bronchial obstruction is only one of the mechanisms responsible for atelectasis.

A definite succession of events occurred when atelectasis was produced under the conditions of their experiments. An initial stasis of the pulmonary arteries followed by patchy, then diffuse atelectasis and eventually by edema and pneumonitis, abscess formation and necrosis was demonstrated experimentally.

Partial bronchial obstruction results in an infectious state resembling human bronchopneumonia—but not in atelectasis, because there is preservation of the respiratory movements permitting inflation and deflation. Removal of the cause of atelectasis prior to development of edema and pneumonitis allows return of the lungs to a normal state. Return to normal may be accelerated by artificial respiration.

It may be deduced from the results of the experiments described that the basic cause of pulmonary atelectasis is interference with respiratory movements (inflation and deflation of the lungs). It is apparent that many causes may produce such interference.

In a study of the pathogenesis of postoperative pulmonary atelectasis, Iglauer [30] was unable to discover any factors that might aid in explaining the occurrence of atelectasis after tonsillectomy under local anesthesia in a patient observed by him. The patient, aged 18, was given morphine sulfate, ⅙ grain (0.01 Gm.), with atropine sulfate preliminary to operation. Local anesthesia was induced with procaine hydrochloride in a 1 per cent solution. Within twenty-four hours there was evidence of collapse of the lower part of the right lung. Use of the bronchoscope was resorted to, and 3 cc. of mucopurulent material was removed. The patient made a complete recovery. Iglauer suggested a possible relation between the occurrence of atelectasis and post-tonsillectomic pulmonary abscess.

Use of the Bronchoscope in Cases of Tuberculosis.—Since patients in whom pulmonary tuberculosis is complicated by tuberculous tracheobronchitis have a relatively grave prognosis, Samson and his associates [31] expressed the opinion that clinical recognition of this complication should be of interest to phthisiologists. They employed the term tuberculous tracheobronchitis to denote a specific mucosal or submucosal infection

30. Iglauer, S.: Pulmonary Collapse Following Tonsillectomy Under Local Anesthesia, Arch. Otolaryng. **25**:382 (April) 1937.

31. Samson, P. C.; Barnwell, J.; Littig, J., and Bugher, J. C.: Tuberculous Tracheobronchitis, J. A. M. A. **108**:1850 (May 29) 1937.

of the trachea and the bronchi in order to distinguish it from tuberculosis of the tracheobronchial lymph nodes.

The following points were brought out in the summary of their report:

A positive diagnosis of tuberculous tracheobronchitis was made in 55 cases, in 24 of which the patient had been observed for a year or longer. On the basis of the type of lesion seen, the patients were divided into two clinical groups, which were of prognostic significance: group 1, those patients (17) in whom the lesion was ulcerative and stenotic; group 2, those patients (7) in whom the lesion was nonulcerative and nonstenotic. Of the 17 patients in group 1, none had returned to complete health and 9 (52.9 per cent) were dead. Major collapse therapy for parenchymal pulmonary tuberculosis had had no favorable effect on the ulcerative tracheobronchial lesions. The nonulcerative and nonstenotic type of tuberculous tracheobronchitis is considered relatively less active than the ulcerative type. For this reason collapse therapy was recommended as indicated for the parenchymal tuberculosis. Four of the 7 patients had had thoracoplasty and at the time the report was made had closed cavities and normal sputum. The other 3 had intermittently positive sputum; the relation of this symptom to tracheobronchial disease is not clear. Temporary paralysis of the hemidiaphragm was used in 2 cases and pneumothorax in 1.

In selected cases symptomatic improvement followed bronchoscopic aspiration of retained secretions, chemical shrinkage of the edematous mucosa or careful dilation of circumscribed bronchial stenoses.

The cases of 8 of 12 patients who had had a series of roentgen treatments were followed for three months or longer. The majority of those patients, whose lesions were chronic, hyperplastic and granuloulcerative, showed a regression of the disease when reexamined bronchoscopically.

Because of the poor results obtained in the past, the authors stated that they were not recommending any type of major collapse therapy for parenchymal tuberculosis in the presence of ulcerative tuberculous tracheobronchitis unless on bronchoscopic reexamination it was apparent that the ulcerative lesions were healing without the formation of highly obstructive fibrosis.

Moorhead [32] reported a case, that of a child aged 17 months, in which the physical signs and roentgen findings suggested the presence of a bronchial foreign body: There was partial obstruction of the right bronchus, with obstructive emphysema. On bronchoscopic examination a mass of granulations was found obstructing the bronchial lumen. This mass was removed and diagnosed histologically as tuberculous granulation tis-

32. Moorhead, R. L.: Tuberculoma of the Bronchus: Report of a Case, Ann. Otol., Rhin. & Laryng. **46**:754 (Sept.) 1937.

sue. The child remained well for one month, at the end of which time the bronchial obstruction recurred. The bronchoscope was again employed, and granulation tissue was again removed. In addition, irradiation therapy was given. There had been no recurrence of the obstruction since the last bronchoscopic examination, two and one-half years previously.

According to Kernan,[33] tuberculosis of the trachea and the main bronchi, as observed by the bronchoscopist, may occur as shallow ulcerations, tuberculous tumors within the lumen of the airway, general thickening and distortion of the wall of the trachea or the bronchi and stenosis caused by pressure from enlarged lymph nodes. The author cited cases to illustrate the diagnostic problems involved, the findings noted on bronchoscopic examination and the methods of treatment employed. He found that the ordinary methods for dilating a tuberculous stricture of the bronchus was not satisfactory and recommended the application of the negative pole of a galvanic current through a specially devised applicator. Shallow ulcers may be treated by coagulation or by topical application of a 10 per cent solution of silver nitrate. In the use of silver nitrate care must be exercised to avoid excessive cauterization, which may result in the formation of scar tissue and additional cicatrization. The beneficial effects of quartz rays on laryngeal lesions suggested that a quartz rod could be inserted through the bronchoscope so that its rays could be applied directly to the areas of ulceration. Although this method had been employed in only a few cases, Kernan expressed the belief that it was worthy of further trial.

The importance of bronchoscopic examination in the diagnosis of obscure tracheal obstruction was demonstrated in a case reported by Lewy.[34] Obliteration of the second portion of the subclavian artery had been discovered at an operation. The patient had left the hospital four weeks later. On her return, four months after dismissal, she was very dyspneic. The heart and lungs were essentially normal. A diagnosis of obstruction of the trachea was made, and bronchoscopic examination was advised.

By means of the bronchoscope a mass about the size of a marble was observed bulging into the lumen of the trachea above the carina. This obstructed about three fourths of the tracheal airway. A biopsy was done. The histologic diagnosis was fibrocaseous tuberculosis. A second bronchoscopic examination was performed, and roentgen therapy was instituted, with temporary improvement. The patient died. The diagnosis at autopsy was ulcerative caseous tuberculosis of the lower

33. Kernan, J. D.: Tuberculosis of the Trachea and Main Bronchi, Ann. Otol., Rhin. & Laryng. **46**:763 (Sept.) 1937; Laryngoscope **47**:777 (Nov.) 1937.

34. Lewy, R. B.: Tuberculosis of the Trachea with Syphilitic Endocarditis and Occlusion of the Left Subclavian Artery, Ann. Otol., Rhin. & Laryng. **46**:735 (Sept.) 1937.

portion of the trachea with fibrocaseous tuberculosis of the paratracheal and right hilar lymph nodes and a primary tuberculous lesion of the lower lobe of the right lung.

Vinson and Toone [35] reported 2 cases of unexplained hemoptysis in which no demonstrable pulmonary lesion could be found by the ordinary methods of examination. No tubercle bacilli were found in any of several studies of the sputum. On the basis of the negative findings bronchoscopic study was recommended. In 1 case extensive scarring of the mesial wall of the right bronchus, with angulation of the bronchial lumen, was found. A dark mass resembling an anthracotic lymph node was observed protruding into the lumen. Biopsy confirmed the presence of anthrax. In the other case an area of scarring with small projections of bleeding tissue was observed in the left main bronchus. This condition was interpreted as ulceration of a hilar tuberculous lymph node into the bronchus. Biopsy was not done.

Bronchiectasis secondary to tuberculous bronchial obstruction is not uncommon. Cohen and Higgins [36] observed 19 patients with bronchial obstruction, 17 of whom had signs or symptoms of bronchiectasis. They expressed the belief that bronchial obstruction and infection of the bronchial wall were the primary etiologic factors in this condition. The presence of wheezing, stridor and dyspnea should always suggest bronchial obstruction. Unexplained cough, expectoration, coarse rales or rhonchi should suggest bronchiectasis.

The diagnosis of bronchiectasis should be confirmed by bronchoscopic examination and the use of iodized oil. The authors expressed the belief that use of the bronchoscope is invaluable not only for diagnosis but for local treatment and that it is a relatively safe procedure in the presence of pulmonary tuberculosis and should not be withheld when indicated. Treatment of bronchial obstruction has not been satisfactory. Dilation, cauterization and aspiration through the bronchoscope usually are beneficial but not curative, particularly in cases of cicatricial involvement.

In a series of cases observed by Samson [37] the presence of marked tuberculous tracheobronchitis as a complication of pulmonary tuberculosis resulted in a mortality of approximately 50 per cent, in spite of active treatment directed at the parenchymal lesions. In reporting these

35. Vinson, P. P., and Toone, E. C.: Pulmonary Symptoms Resulting from Ulceration of Hilar Lymph Nodes into a Bronchus, West Virginia M. J. **33**:200 (May) 1937.

36. Cohen, S. S., and Higgins, G. K.: Bronchiectasis Associated with Tuberculous Bronchial Obstruction, Am. Rev. Tuberc. **36**:711 (Dec.) 1937.

37. Samson, P. C.: Diagnosis, Treatment and Prognosis in Tuberculous Tracheobronchitis, J. Thoracic Surg. **6**:561 (June) 1937.

cases Samson discussed the clinical and bronchoscopic characteristics by which the parenchymal lesions may be recognized, the relation of these lesions to prognosis of pulmonary tuberculosis with or without collapse therapy and the means of treatment available. He stated that tuberculous tracheobronchitis can be considered a definite clinical entity, the diagnosis of which is based on observation of rather characteristic symptoms, physical examination and a study of serial roentgenograms. Confirmatory bronchoscopic examination is important. Four types of lesions seen bronchoscopically are the nonulcerative, the ulcerative, the hyperplastic and the fibrostenotic type; several types often coexist in the same patient. Of more than 50 patients with recognized tuberculous tracheobronchitis, 24 were observed for at least one year or until death. The relatively grave prognosis for patients with ulcerative and stenotic lesions was shown by the 52.9 per cent mortality in this group. The apparent ineffectualness of pulmonary collapse therapy in this particular group was demonstrated. Various methods of treatment of tuberculous tracheobronchitis were considered. In selected cases use of the bronchoscope gave symptomatic relief. In 5 cases of chronic hyperplastic and granuloulcerative tracheobronchial mucosal tuberculosis, the use of roentgen therapy apparently resulted in a regression of the lesions.

TUMOR OF THE TRACHEA AND OF THE BRONCHUS

Amyloid Tumor of the Trachea.—Tumor of the trachea is rare, particularly in comparison with tumor of the larynx and of the bronchus. Benign tumor is found twice as frequently as malignant tumor. Lipoma, papilloma, fibroma, intratracheal goiter, chondroma and osteoma have been observed. Block and Soulas[38] reported a case of amyloid tumor in a woman aged 46. There were symptoms of obstruction (dyspnea with some cough) but no expectoration. When examined with the mirror laryngoscope the larynx appeared normal, but beneath the glottis was seen a red mass. Bronchoscopic examination was attempted, but dyspnea increased, necessitating immediate tracheotomy. After the tracheotomy bronchoscopic examination was performed. It showed a sessile, reddish tumor immediately below the glottis, obstructing two thirds of the tracheal airway. This tumor appeared to be attached to the left lateral wall but was in contact with both the anterior and the posterior wall. The tumor bled easily on contact with the tip of the bronchoscope. Removal of the tumor was carried out with a forceps. The base was between 2 and 3 cm. in diameter. There was prompt relief from dyspnea. The patient was observed again in three months and was found free from symptoms. The histologic diagnosis was amyloid tumor of the trachea.

38. Block, A., and Soulas, A.: Amyloid Tumors of the Trachea, Bronchoscop., œsophagoscop. et gastroscop. **3**:211 (July) 1937.

Adenoma of the Bronchus.—Routine bronchoscopic examination has disproved the belief that benign tumor of the bronchus is rare. Zamora and Schuster [39] reviewed the records of 24 cases of benign tumor of the bronchus that had been reported as instances of vascular adenoma. From the standpoint of symptoms the cases divided themselves into two groups according to the extent of bronchial obstruction. Repeated small hemorrhages were a common and often an only symptom. With the development of bronchial obstruction a greater variety of symptoms was observed. The authors reported 5 additional cases and discussed 2 of them in detail. From the bronchoscopic standpoint the appearances were rather characteristic. The lesion was usually rounded and congested and gave the impression of absence of infiltration and fixation. The problem of removal in such cases is largely mechanical. In the opinion of the writers implantation of radon seeds is probably the treatment of choice.

Bronchoscopic findings in cases of pulmonary neoplasm, whether positive or negative, are important not only in diagnosis but in determination of the plan of treatment to be employed. Jackson and Konzelman [40] discussed the importance of the bronchoscopic findings in cases of tumor of the bronchus and cited their experiences in a series of 12 cases of benign bronchial tumor, the so-called bronchial adenoma. Brief reports of the findings in each case were included. In the opinion of the writers diagnostic examination with the bronchoscope is of value in such cases, whether or not the tumor is visualized in the accessible bronchi and specimens are taken for biopsy, because it may show indirect evidence of neoplasm; if results are entirely negative this demonstrates the normality of the larger bronchi, thus indicating the feasibility of surgical extirpation. One of the most important types of bronchial tumor is the so-called benign adenoma, which is coming to be recognized as a clinical and pathologic entity. The histologic picture of the so-called benign adenoma is confusing to pathologists unfamiliar with this type of tumor, for while the cellular pattern is fairly uniform and constant, it is not comparable to that seen in benign glandular tumors elsewhere. Bronchoscopic treatment, by removal with a forceps, electrocoagulation, radon or radium, is especially effective in a case of benign tumor, and it is at least of palliative value in a case of malignant tumor.

Carcinoma of the Bronchus.—The remarkable disproportion between the large number of reported cases of primary carcinoma of the bronchus and the small number of such cases in which treatment has been suc-

39. Zamora, A. M., and Schuster, N.: Vascular Adenoma of the Bronchus, J. Laryng. & Otol. **52**:337 (May) 1937.

40. Jackson, C. L., and Konzelman, F. W.: Bronchoscopic Aspects of Bronchial Tumors with Special Reference to So-Called Bronchial Adenoma: Reports of Twelve Cases, J. Thoracic Surg. **6**:312 (Feb.) 1937.

cessful suggests that an inquiry be made to ascertain its causes. It is generally recognized that roentgen and bronchoscopic examination have aided immeasurably in the diagnosis of bronchial carcinoma. With recent advances in thoracic surgery, lobectomy and even pneumonectomy in selected cases are considered relatively safe procedures. Improvement in equipment and in technic in the employment of the roentgen rays and of radium in therapy gives the hope that relief can be secured by these agents.

In a study of 100 consecutive cases of carcinoma of the bronchus in which the diagnosis was made bronchoscopically on the basis of biopsy, Omerod [41] found that in 62 the growth was a squamous cell and in 38 a nonsquamous cell carcinoma. The two types were found to occur with equal frequency in all three zones of the lung and to pursue practically the same clinical course. While the number of cases of successful lobectomy and pneumonectomy is increasing, in a large majority of Omerod's cases the growth was found to be too far advanced to permit of the employment of these procedures. It was therefore found necessary to attempt its destruction by less radical measures. The method which has been largely followed by the author is the introduction of radon into the bronchus. Radon seeds may be inserted directly into the tumor, or they may be applied in some form of container which can be left in the bronchus for a long time and then removed. The advantage of radon seeds is that they may be introduced directly into the tumor instead of being placed alongside it in the bronchial lumen; they can be distributed in distant portions of the growth, and they are more likely to remain in position. When one considers the type and the inaccessibility of the growths in the cases reported, the results appear very satisfactory. The average life of the untreated patients was three and one-half months, and that of the treated patients, seven and eight-tenths months.

Bronchoscopic study of carcinoma of the bronchus consists of inspection of the tracheobronchial tree and interpretation of the findings. Malignant disease of the lung manifests itself in most cases by one of the types of obstruction. Holinger [42] discussed the bronchoscopic aspects of carcinoma of the bronchus. The bronchoscopic finding of fixation of the mediastinal structures together with widening of the trachea at the bifurcation, in themselves diagnostic features of carcinoma of the bronchus, is indicative of metastasis to the peritracheal and peribronchial lymph nodes.

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41. Omerod, F. C.: The Pathology and Treatment of Carcinoma of the Bronchus, J. Laryng. & Otol. **52**:733 (Nov.) 1937.

42. Holinger, P. H.: Diagnosis of Bronchogenic Carcinoma: Bronchoscopic Aspects, Illinois M. J. **72**:437 (Nov.) 1937.

Pressman and Emery [43] discussed the various methods of applying radium and the technical difficulties encountered in the direct application of radium through a bronchoscope to a growth of the trachea or of the bronchi. Since in the majority of cases a malignant neoplasm originates at the lower end of the trachea, at its bifurcation, or in a main stem bronchus, they proposed a method of overcoming the obstacles encountered in application of radium to these areas. They employed cylinders that are hollow ("bird cage") or enclosed in a flexible rubber catheter. The entire circumference of the involved bronchus is irradiated, not only at the site of the lesion but also for some distance above and below it. Complications to be prevented are hemorrhage, massive pulmonary collapse, pulmonary sepsis and bronchial stenosis. To obviate the occurrence of massive collapse following the lodgment of so large a foreign body, the authors use preliminary pneumothorax treatment and continue it during the period of lodgment. The reaction usually lasts from six to eight weeks. They stated the belief that in properly selected cases in which the condition is in an early stage this method provides adequate radiation throughout all portions of the neoplasm, including extension in the epithelium itself and to the submucosal lymphatics.

In discussing the question of increase in the incidence of primary carcinoma of the bronchus, Zinn [44] expressed the view that by far the greatest reason for the apparent increase in pulmonary carcinoma is the cooperation between the internist, the roentgenologist, the bronchoscopist, the pathologist and the thoracic surgeon.

In diagnosis, recognition of the early symptoms is important. Roentgen examination of the chest is invaluable. Bronchoscopic examination with biopsy is the only positive means of final diagnosis. While one cannot determine the extent of the lesion by bronchoscopic examination, one can ascertain the location of the growth and aid the surgeon in selecting the cases in which the disease is considered best suited for operation.

In discussing the importance of early diagnosis of carcinoma of the bronchus from the standpoint of treatment, Clerf [45] stated that collected data concerning cases of carcinoma of the bronchus show conclusively that the diagnosis is commonly made late in the disease, when surgical treatment can no longer be considered. In a large number, probably in a majority, of the cases the diagnosis could have been made early if

43. Pressman, J. J., and Emery, C. K.: A New Method of Radium Application in Carcinoma of the Bronchus, Ann. Otol., Rhin. & Laryng. **46**:314 (June) 1937.

44. Zinn, W. T.: Diagnosis and Treatment of Primary Bronchial Carcinoma, Ann. Otol., Rhin. & Laryng. **46**:818 (Sept.) 1937.

45. Clerf, L. H.: Carcinoma of the Bronchus, Radiology **28**:438 (April) 1937.

there had been an opportunity to carry out all the recognized diagnostic procedures. The clinician should consider bronchial carcinoma as a diagnostic possibility and should carefully interpret the early symptoms, such as cough without or with sputum, blood streaking, pain and wheeze. The symptoms of advanced disease should not be waited for. Roentgenograms should be secured early.

The roentgenologist should be conversant with the clinical history and the symptoms. Study of the chest should include an examination for obstructive emphysema.

The bronchoscopist should be given an opportunity to investigate endoscopically all cases of obstructive emphysema or of obstructive atelectasis. Unexplained cough, hemoptysis and wheeze also warrant bronchoscopic examination. Instillation of iodized oil should be employed as a supplementary aid. Above all, there should be close cooperation between the clinician, the roentgenologist and the bronchoscopist. In a case in which there are unexplained pathologic findings, the thoracic surgeon should be consulted.

Although carcinoma of the bronchus is commonly observed in persons over 40 years of age, its occurrence in younger persons has been recorded. Hailwood [46] reported a case of carcinoma of the bronchus in a youth aged 19. The history was suggestive of pulmonary tuberculosis. A diagnosis was made on the basis of the results of roentgen examination after instillation of iodized oil. The roentgenograms showed evidence of obstruction of the left bronchus. The diagnosis was corroborated histologically by biopsy of a node on the wall of the chest. Unfortunately, bronchoscopic examination was not made.

PULMONARY ABSCESS

In a review of the literature on pulmonary abscess, Mathews [47] found that there is an increased frequency of occurrence of the condition in children. He reported 12 cases. In 3 the condition followed tonsillectomy and adenoidectomy; in 1, reduction under ether of a complicated fracture; in 1, aspiration of a peanut shell; in 1, aspiration of blood from nosebleed; in 1, otitis media; in 1, an acute infection of the upper respiratory tract, and in 2, pneumonia. In 2 the origin was unknown. He expressed the opinion that the wholesale removal of tonsils of children might account for this increase. In support of the aspiration theory of infection he observed that the right lung was involved more often than the left. It is of interest to note that fusiform bacilli and spiro-

46. Hailwood, J. G.: Carcinoma of the Bronchus in a Boy Aged Nineteen, Brit. M. J. **1**:606 (March 30) 1937.

47. Mathews, F. P.: Lung Abscess in Children, Arch. Pediat. **54**:1 (Jan.) 1937.

chetes, common in cases of abscess in adults, were not found in children. Medical treatment for six weeks was advised. If there was no improvement, bronchoscopic aspiration was recommended; if progress became stationary, surgical treatment was advised. The prognosis is favorable, particularly when compared with that for adults.

In discussing the treatment of pulmonary abscess, Jackson [48] directed attention to the importance of restoration of and maintenance of proper drainage of the tracheobronchial tree, whether external drainage is established or not. In all cases of pulmonary abscess in which external drainage is contraindicated or postponed, bronchscopic supervision of and maintenance of tracheobronchial drainage are indicated. Catheter aspiration of a pulmonary abscess by the nurse every few minutes or every few hours, as indicated, is an invaluable curative measure for all patients wearing a tracheotomic cannula. The results are so good in such patients as to justify in each case of pulmonary abscess consideration, at least, of the advisability of tracheotomy to facilitate this method of frequent aspiration. It cannot be too strongly emphasized that tracheobronchial aspiration of a pulmonary abscess does not require insertion of the aspirating tube into the abscess cavity. All that is necessary is to clear away obstruction and aspirate the pus as it is forced into the larger bronchi by the repeated tussive squeeze.

Hall and Thomas [49] reviewed the literature of pulmonary abscess and reported a personal series of 24 cases. In 6 of these the condition followed tonsillectomy; in 2, abdominal operation; in 1, fracture of a femur; in another, fracture of a maxillary sinus; in 3, an infection of the upper respiratory tract, and in 1, pneumonia. In the remaining 7 cases no definite predisposing etiologic factors were found. The writers indicated that they were not in accord with the opinion that some form of thoracic surgical intervention is necessary for all patients not recovering spontaneously. Seven patients with acute abscess were treated bronchoscopically and medically; there were 6 recoveries. Of the 17 patients with chronic abscess, 1 recovered after use of the bronchoscope alone, 2 responded to use of the bronchoscope and surgical treatment and the remaining 13 required some form of surgical treatment.

In bronchoscopotherapy the procedures discussed by Soulas [50] consisted of aspiration of secretions, use of topical applications, cauterization, catheterization of bronchial orifices, removal of granulations,

48. Jackson, C.: Pulmonary Abscess in Adults and Children, South. Surgeon **6**: 207 (June) 1937.

49. Hall, S. S., and Thomas, H. V.: Lung Abscess: Bronchoscopic Considerations, Ann. Otol., Rhin. & Laryng. **46**:790 (Sept.) 1937.

50. Soulas, A.: Bronchoscopotherapy in Bronchopulmonary Suppuration: Its Mechanism and Results, J. Laryng. & Otol. **52**:249 (April) 1937; Proc. Roy. Soc. Med. **30**:32 (Feb.) 1937.

instillation of solutions in small quantities and lavage of the main bronchi. The aim of these procedures is the improvement of drainage and ventilation, the removal of secretions and the avoidance of stagnation.

Tracheobronchial drowning resulting from a sudden and rapid flow of secretions into the airway may produce serious obstruction of the trachea and of the larger bronchi. The author observed 2 such cases. In 1, in which collapse of the lung followed an operation for pulmonary abscess, there were flooding of the airway with pus and impending asphyxiation. In another case there was aspiration of vomitus after an operation with general anesthesia. In both cases prompt bronchoscopic aspiration of secretions resulted in immediate disappearance of symptoms. In certain cases of bronchopneumonia similar phenomena are observed, owing to the presence of large quantities of mucopurulent secretion in the airway. The author treated 3 patients with this condition, all of whom showed good results. The results were due chiefly to employment of mechanical measures.

In the treatment of pulmonary atelectasis one must distinguish between this condition and bronchopulmonary suppuration resulting from obstruction by a foreign body. Atelectasis produced by small quantities of thick secretion is promptly and completely relieved by aspiration. In some cases of suppuration due to the impaction of a foreign body, serious suppuration may remain even after removal of the obstruction.

A pulmonary abscess usually does not respond to operation alone. Often one must employ all the procedures mentioned. The percentage of patients cured of recent abscess is from 70 to 75. An additional 15 per cent, patients improved by bronchoscopic treatment, may be operated on successfully. In cases of bronchiectasis use of the bronchoscope has a double purpose: removal of inflammatory and infective conditions resembling bronchopneumonia and removal of pus. This purpose is accomplished by aspiration, injection and lavage of the bronchi at intervals over long periods.

BRONCHIECTASIS

In a review of the literature of bronchiectasis Ferguson [51] stated that mechanical obstruction of a bronchus is one of the most important factors in the causation of the disease. The frequent development of bronchiectasis during or shortly after one of the acute infectious diseases of childhood suggests the need for careful study of the chest when signs of pulmonary involvement are present. In these cases and in those of children with chronic cough bronchoscopic examination for diagnosis is indicated. In the early stages of bronchiectasis a cure may be effected

51. Ferguson, G. B.: Bronchiectasis in Children with Special Reference to Prevention, Arch. Otolaryng. **25**:430 (April) 1937.

by providing and maintaining free pulmonary drainage by bronchoscopic aspiration, carrying out suitable general measures and caring for the nose and the throat.

LUNG MAPPING

A method of exploration of the lung with iodized oil was described by Goldman and Adams.[52] They stated the belief that endobronchial probing combined with serial selective bronchographic examination fluoroscopically controlled has given better results than any other method in solving certain diagnostic problems confronting the thoracic surgeon. While use of the bronchoscope is invaluable for obtaining a specimen for biopsy, exploration with iodized oil by its use has been found wanting in answering the questions asked by the thoracic surgeon. The described method is not a substitute for use of the bronchoscope. Endobronchial probing with serial selective bronchographic examination requires the services of both the roentgenologist and the thoracic surgeon. Use of the described method eliminates many of the potential dangers associated with instilling iodized oil into the lung.

Jackson and Bonnier [53] briefly reviewed the history of the development of lung mapping and referred to certain authors of the literature pertaining to this subject. They agreed with other writers that the catheter methods for the instillation of iodized oil are the best. They did not wish to imply, however, that these procedures should supplant diagnostic bronchoscopic examination; they inferred, rather, that the catheter methods should be considered supplemental. The authors appended a long list of references to their article.

FOREIGN BODY IN THE BRONCHUS

The case of foreign body reported by Schugt [54] should serve as a warning to physicians as to the possibility of one's breaking a wooden tongue depressor while depressing the tongue and of its being aspirated. It should also warn them of the importance of prompt investigation of the location of the foreign body if such an accident occurs, in order that appropriate treatment may be carried out. In the case reported the distal fragment of the broken tongue depressor was aspirated. This, however, was not known until about sixteen days later, when a condition developed that was diagnosed as pneumonia. On bronchoscopic examination the fragment of the tongue depressor was found in the lower

52. Goldman, A., and Adams, R.: Endobronchial Probing Combined with Serial Selective Bronchography Fluoroscopically Controlled, Ann. Surg. **106**:976 (Dec.) 1937.

53. Jackson, C. L., and Bonnier, M.: Technic of Bronchography, Ann. Otol., Rhin. & Laryng. **46**:771 (Sept.) 1937.

54. Schugt, H. P.: Aspiration of a Wooden Tongue Depressor: Case Report, New York State J. Med. **37**:59 (Jan. 1) 1937.

end of the trachea, resting on the bifurcation. On its removal it was found to measure 6.5 cm. in length. The convalescence was stormy, and the patient was not discharged until eight weeks after admission to the hospital.

In a report of 200 cases of foreign body in the air and food passages, McCannel [55] stated that the majority of the accidents with foreign body occurred in children, of whom 66 per cent were under 5 years of age. In adults the most frequently encountered foreign bodies were bones; these were observed more often in persons wearing artificial dentures. Twenty-four per cent of the foreign bodies were of vegetal origin, 21.5 per cent were bones, 13.5 per cent were coins and 12.5 per cent were pins or nails.

In a series of 30 cases of foreign body in the air passages reported by Bender and Som,[56] it is interesting to note that in 13 the foreign body was a bone. Pulmonary complications were observed in those cases in which the foreign body remained for more than nine weeks. The writers gave abstracts of the case records.

Cummings [57] cited histories of cases of foreign body in the air passages and emphasized certain important points in diagnosis and treatment. He directed attention to the importance of initial symptoms: wheeze, cough, pulmonary infection and bronchial obstruction.

In reporting 6 cases of foreign body in the air and food passages, Carmody [58] remarked that the earlier presentations before the American Bronchoscopic Society were made up largely of reports of experiences with cases of foreign body. At the present time few reports of cases of foreign body are made; attention is now directed to use of the endoscope for diseases not caused by the presence of a foreign body.

In a discussion of the aspiration of nonopaque foreign bodies into the lung, Arbuckle [59] expressed the opinion that this accident occurs more frequently than generally is supposed. Aspirated foreign bodies are various, including any object that may be placed in the mouth. The history is one of the most important factors in the diagnosis. Any possible history should not be disregarded, irrespective of failure to secure evidence of foreign body symptoms. A patient may be examined

55. McCannel, A. D.: Peroral Endoscopy, Canad. M. A. J. **37**:42 (July) 1937.

56. Bender, M. S., and Som, M. L.: Foreign Bodies in Tracheobronchial Tree: Observations and Review of Thirty Consecutive Cases, Am. J. Surg. **36**:462 (May) 1937.

57. Cummings, G. O.: Foreign Bodies in the Tracheo-Bronchial Tree, J. Maine M. A. **28**:275 (Dec.) 1937.

58. Carmody, T. E.: Some Interesting Endoscopic Cases, Ann. Otol., Rhin. & Laryng. **46**:760 (Sept.) 1937.

59. Arbuckle, M. F.: Diagnosis of Nonopaque Foreign Body in the Tracheobronchial Tree, J. Pediat. **11**:356 (Sept.) 1937.

during the symptomless interval and the foreign body overlooked. Wheeze and cough, especially when associated with a history of initial symptoms, are pathognomonic of foreign body in the air passages.

In a review of the literature dealing with the complications associated with the presence of vegetal foreign bodies in the air passages and the mechanical and pathologic changes responsible for their development and on the basis of personal experiences, Hall and Thomas [60] discussed the beneficial effects resulting from oxygen therapy. Concerning the value of this form of treatment they state that it certainly increases the oxygen tension in the tracheobronchial tree, which in itself may decrease serous leakage through the altered cell walls, and that it may even have a repelling influence on the edema already present. It is possible that rapid breaking down of vegetal juices into relatively innocent products may be facilitated by the increase in oxygen. By improving the tracheobronchial ventilation, this treatment improves proportionally the general vascular circulation, encouraging the return of normal factors. It is possible that the additional oxygen so obtained may have a beneficial effect as a ciliary resuscitant. Many tracheotomies may be prevented by the routine use of the oxygen tent on the first signs of development of laryngotracheobronchial edema or occlusion.

In reporting their observations on a series of cases of foreign body, Gill and Pilcher [61] emphasized the importance of considering foreign body as a diagnostic possibility in every case of obscure pulmonary disease and expressed the opinion that patients with unexplained cough should be given the benefit of diagnostic bronchoscopic examination. Of the 164 foreign bodies reported, 92 were found in the air passages and 72 in the food passages. A large proportion of the patients were under 5 years of age. The following fundamental principles were observed in the care of these patients: the employment of proper-sized tubes, the holding of the head in the correct position, the induction of muscular relaxation, and attention to short working time and to team work. Some form of sedation or of anesthesia was employed in every case unless dyspnea was present to secure proper muscular relaxation.

Bozer [62] reviewed a series of approximately 300 cases of foreign body and concluded that the following factors played a prominent role in the 15 recorded deaths: incomplete or delayed diagnosis, improper

60. Hall, S. S., and Thomas, H. V.: The Postbronchoscopic Treatment of Vegetal Foreign Bodies in the Tracheobronchial Tree with Particular Reference to the Use of the Oxygen Tent, West Virginia M. J. **33**:16 (Jan.) 1937.

61. Gill, E. G., and Pilcher, J. A.: Observations in the Management of One Hundred and Sixty-Four Foreign Bodies in the Air and Food Passages, Virginia M. Monthly **64**:201 (July) 1937.

62. Bozer, H. E.: Some Factors Influencing Mortality in Cases of Foreign Body in the Lower Air and Food Passages, Ann. Otol., Rhin. & Laryng. **46**:409 (June) 1937.

manipulation by finger or by bougie, improper preoperative and postoperative care, anesthesia, youth of the patient, perforation of the esophagus, poor judgment in the use of tracheotomy and a lack of specially trained personnel or of proper instruments.

An aspirated foreign body rarely migrates through the lung and the pleural cavity and perforates to or through the skin of the chest wall. In a review of the literature on this subject Seydell [63] found reports of 10 cases, which he presented in abstract form. He also reported a personal case. It is of interest to note that in each instance the foreign body passed through the right bronchus, appearing between the ribs under the right wall of the chest, and that in all cases but 1 it was extruded through the posterior wall. In 10 cases the foreign body was a head of grass; in the remaining case it was a twig from a juniper tree. All these foreign bodies with the possible exception of the juniper twig had the power of spontaneous propulsion. The shortest time which elapsed between the aspiration of the foreign body and its appearance under the skin of the chest wall was eight days; the longest time was one year. The foreign body which took a year to appear was the twig from a juniper tree.

Daily [64] briefly discussed recorded cases of subcutaneous emphysema and reported a personal case. When his patient was first observed there was marked subcutaneous emphysema over the entire chest anteriorly. The emphysema had been noted first in the region of the left nipple, two days previously. There was no history of an accident with a foreign body. The lungs, mediastinum and pleura appeared normal on roentgen examination. A provisional diagnosis of spontaneous rupture of the trachea or of a bronchus was made. Daily made a bronchoscopic examination and found a prune seed in the bronchus of the lower lobe of the right lung. The seed was removed. The bronchoscope was reinserted and the bronchus of the right lower lobe inspected. A longitudinal tear was found in the posterior and inner wall of the bronchus. An application of a 10 per cent solution of silver nitrate was made. The emphysema cleared promptly, being observed last in the region of the left nipple. The patient was discharged twelve days after the bronchoscopic treatment.

The case of bronchial foreign body reported by Benjamin [65] is of interest because of the treatment employed after occurrence of medias-

63. Seydell, E. M.: Spontaneous Perforation of the Wall of the Chest by an Aspirated Foreign Body, Arch. Otolaryng. **26**:189 (Aug.) 1937.

64. Daily, L.: Report of a Case of Subcutaneous Emphysema Caused by a Foreign Body: A Prune Seed in the Bronchus, Ann. Otol., Rhin. & Laryng. **46**: 256 (March) 1937.

65. Benjamin, C. E.: Artificial Pneumothorax in Perforating Injury of the Bronchus by a Pointed Foreign Body, Acta oto-laryng. **25**:1 (Jan.-Feb.) 1937.

tinal emphysema. The patient, a child aged 5 years, had aspirated a brass-headed tack about three months previously. There was atelectasis of the lower and of the middle lobe of the right lung, apparently with perforation of the bronchial wall by the point of the tack. Bronchoscopic removal proved difficult, owing to inflammatory changes, granulation tissue, pus and excessive mucosal swelling. Shortly after removal of the foreign body subcutaneous emphysema was discovered in the neck. Artificial pneumothorax had previously been prepared for and was carried out, the right lung being thus compressed. The patient made a prompt recovery except for certain inflammatory and fibrotic changes which persisted in the lower lobe of the right lung. Roentgenograms made at the end of six months showed that bronchiectasis was still present.

Abstracts from Current Literature

Ear

HARD OF HEARING SCHOOL CHILDREN. C. T. UREN, Nebraska M. J. **2**:300 (Aug. 7) 1937.

The first step in a program for the management of school children who are hard of hearing is the detection of the hearing defects. With a 4-A audiometer as many as 40 children can be tested at one time and in about twenty minutes. The average number of hearing defects runs between 60 and 140 per thousand children. The second step is a visit to the parents of the child with a hearing defect by the school nurse to talk over the situation. The third step is to send the child somewhere for medical help. Often the parents are unaware that the child has a hearing defect. Only 37 per cent of the parents of the children examined in Omaha knew that their children's hearing was defective. Now 400 underprivileged children are being examined in the offices of 15 otologists in Omaha. About 50 per cent of these children are in need of tonsillectomy and adenoidectomy. A program of this type is not complete without proper instruction in lip reading and speech correction. Lip reading will better enable the child who is hard of hearing to remain in school. Mechanical aids should be advised when indicated, but lip reading should not be neglected in those who are helped by hearing devices.

HAMILTON, Omaha. [AM. J. DIS. CHILD.]

ACUTE OTITIS MEDIA AND MASTOIDITIS: THE INDICATIONS FOR OPERATION. I. S. HALL, Edinburgh M. J. **44**:298 (May) 1937.

This paper is the thirteenth contribution on "Clinical Recollections and Reflections," a series which has been running in the *Edinburgh Medical Journal*. It deals with the definition and treatment of acute otitis media. In answer to the question whether it is justifiable to perform paracentesis because of safety from the possible production of mastoiditis, the author quotes figures from the Royal Infirmary: Of 221 patients who had the ear drum punctured, 28 had a mastoid operation subsequently, which Hall considers a small proportion. Of 189 on whom mastoid operations were performed, only 28 had previous paracentesis.

The restoration or maintenance of hearing should be considered in any operative procedure on the ear. A purulent discharge over a long period causes damage to the hearing. Operation on the mastoid should shorten the period of suppuration and therefore help the return of the middle ear to health and function.

Increasing toxemia, a rising pulse rate and periosteal edema are evidences of advancing infection. Tenderness over the mastoid is not always a reliable symptom. Throbbing pain or unilateral headache deserves constant consideration. The roentgen picture may help greatly in interpreting local signs.

Hall considers that operation on the mastoid is indicated (1) when infection spreads outside the mastoid; (2) when there are intracranial symptoms; (3) when there has been continued purulent discharge for as long as five weeks, even in the absence of other symptoms; (4) when toxemia is associated with pain after paracentesis, or (5) when in the presence of such symptoms the ear has stopped discharging. Increasing deafness accompanying copious discharge in a case of known mastoid disease also calls for operation.

NEFF, Kansas City, Mo. [AM. J. DIS. CHILD.]

OTOLOGIC EXAMINATION OF DEAF-MUTE STUDENTS. F. THIES, Ztschr. f. Hals-, Nasen- u. Ohrenh. **39**:536, 1936.

Thies was interested in the residual hearing capacity of deaf-mutes. His aim was to determine whether deaf-mutes have a capacity for the auditory perception

of sounds and to what extent they can utilize this capacity, and also whether deafness is hereditary or not. Tests were made on 93 deaf-mute children, whose ages varied between 9 and 14 years. After the ears, noses and throats of these children had been examined for suppurations or for residues of such conditions, the children were subjected to tests with an oto-audion. The author describes the tests and discusses their results. He found that 69 of the 93 children examined could hear sounds and differentiate vowels; 4 others could hear sounds but were incapable of differentiating vowels, and 20 had no hearing capacity. In order to obtain more information about the cause of the deafness, particularly about the hereditary character, caloric and rotatory tests were made, and the anamnesis was investigated. Moreover, the oto-audion curves for the two ears were compared, and they were found to be identical in 25 of the cases. In 23 of these 25, the anamnesis indicated hereditary deafness. However, the author concludes that his examinations indicated that aside from examining the anamnesis there is no reliable method for differentiation between acquired and hereditary deafness.

EDITOR'S ABSTRACT.

BURNING OF THE AUDITORY CANAL, MIDDLE EAR AND LABYRINTH IN WELDERS AND CASTERS. O. HEERMANN, Ztschr. f. Hals-, Nasen- u. Ohrenh. **39**:546, 1936.

Heermann reports the clinical histories of fifteen cases of injury of the ear in welders and casters by burning. Some of the histories are not complete, because these patients requested medical aid only in the later stages of the disorder. The author does not include in this report cases in which only the auricle was burned, but considers only those cases in which drops or sparks entered the meatus and were able to take effect until they cooled, thus causing a more severe impairment than results from burns of the external ear. In all except one of the reported cases, the tympanic membrane was injured. The anamneses indicate that nearly all these accidents occur in the welding and casting shops of the iron and steel factories when sparks or metal drops enter the ear and burn the meatus, the tympanic membrane and the middle ear and occasionally even the labyrinth. The higher incidence of such burns in the left ear the author regards as the result of the position during work of the usual right-handed person. The author thinks that in order to prevent such injuries of the ears in casters and welders, such workers should wear suitable ear protectors, just as they wear eye protectors.

EDITOR'S ABSTRACT.

DEEP OTOGENIC INFLAMMATION OF TEMPORAL BONE: PETROSITIS. ROBERT LUND, Hospitalstid. **80**:313 (March 23) 1937.

Lund discusses simple petrositis and osteitis of the petrous portion of the temporal bone on the basis of 54 cases, 38 of acute or subacute suppuration of the middle ear, 13 of simple chronic suppuration and 3 of cholesteatomatous suppuration. Eighty-nine foci were emptied, 15 anterior and 74 posterior, the greater number of interventions on posterior foci being due in part to their greater accessibility. He states that the main symptom of deep osteitis is pain, which differs in character and localization from the usual aural pain. It is generally neuralgic, most often violent and frequently localized in one or more of the fields of the trigeminal branches. Thirteen children under 10 years old made no definite statement as to pain. In part of the second group of 24 cases there was pain, which was sometimes violent but was indefinite. In the remaining 18 cases the pain was typical of petrositis. In 11 of the 14 cases of acute suppuration of the middle ear the pain began during the first days of the suppuration; in 3 cases it began on the seventeenth, the thirteenth and the forty-first day, respectively. Seven of the 11 patients recovered after the first intervention; 4 required repeated operation.

When acute suppuration of the middle ear is complicated with partial or total petrositis, the typical neuralgiform pain is usually present from the start of the

suppuration and the patient must be followed clinically and roentgenologically with great care. When the field of all the trigeminal branches is affected, the gasserian ganglion is likely to be involved. Such involvement is certain if disturbance in sensibility in the region of the trigeminal nerve is also established. The neuralgic pain in the orbits emphasized in the literature occurred in only 4 of the cases, in 3 of which the apex was affected. In 3 cases there was no orbital pain in spite of total petrositis. When focus VI is being emptied, especially when the osteitis continues into focus III, as it often does, the facial nerve is sometimes exposed above the styloid foramen, usually without the lesion's causing postoperative paralysis of the nerve (6 cases); the prognosis is favorable. In 7 of the 19 cases in which marked involvement of the labyrinth was present there was complete destruction of the labyrinth, and in two, fistulous breaking through into the labyrinth. When the labyrinth is involved during the course of suppuration of the ear, every effort should be made to determine whether or not petrositis is present. If apicitis is not diagnosed before paralysis of the abducens nerve is manifest, there will often be marked meningitis. Except when recovery follows operation in the subacute stage, subacute petrositis ends either with spontaneous recovery or with death due to intracranial complications. Petrositis early in the course of suppuration of the middle ear without actual osteitis tends to spontaneous recovery, and in a later stage, when there is osteitis in the temporal bone, the prognosis is good without deep intervention. In the subacute stages of the osteitis the disorder is so variable in localization and extent that the prognosis is uncertain.

Acute or chronic suppuration of the middle ear with checked pneumatization and deep osteitis means considerable danger of retention foci and perforation toward the cranial cavity or the large blood vessels. In the first stages of early petrositis, paracentesis or eventual mastoidectomy usually leads to recovery, even when there is violent neuralgic pain or paralysis of the abductor muscles. From about the third to the sixth week, when mastoidectomy is indicated, otologists seem to agree that in the operation the labyrinthine foci should be emptied if the osteitis has continued into them, and the possibility of such continuation should be investigated even when the symptoms of deep osteitis are absent. The author would avoid deeper penetration into the pars petrosa than is strictly necessary; he prefers to repeat and extend the intervention, awaiting the result of each operation and closely observing the patient. He says that, while for deep epidural abscess external intervention in combination with emptying by the inner way may be required, as an independent operation this method has been entirely supplanted by the intervention from within, and he regards the endoapical operation as a rational method.

HEKTOEN, Westby, Wis.

Pharynx

INDICATIONS AND CONTRAINDICATIONS FOR TONSILLECTOMY AND ADENOIDECTOMY. T. M. GOODWIN, West Virginia M. J. **33**:250 (June) 1937.

The indications that justify tonsillectomy and adenoidectomy are:

1. Repeated attacks of acute tonsillitis or peritonsillar abscess
2. Continuous head colds
3. Obstructive nasal breathing (adenoids)
4. Cervical adenitis if due to tonsillar infection
5. Hypertrophy of tonsils if this is sufficient to impede respiration and the swallowing of food
6. History of acute catarrhal or suppurative otitis media
7. Mouth breathing
8. Repeated attacks of pharyngitis, laryngitis or bronchitis
9. History of rheumatism, endocarditis, chorea or nephritis
10. Tonsils proved to be carriers of diphtheria

11. Tuberculous infection of the tonsils—with great care in the selection of cases
12. Continuous discharge from the nose in the absence of sinusitis
13. "Buried" tonsils with definite evidence of disease

The contraindications are:

1. Acute tonsillitis within a period of two weeks
2. Convalescence from serious illness
3. Hemophilia or other blood dyscrasia
4. Active syphilis or tuberculosis
5. Menstruation occurring just before or during period of operation
6. Chronic arthritis with joint changes
7. Anomalous arteries in or near the tonsils
8. Hypertension of 200 or more
9. Cardiac involvement—calls for choice of time and anesthetic and a consultation
10. Exposure to infectious disease—calls for delay
11. Lesion in the mouth
12. Sinus or nasal disease must be cleared up
13. Loose teeth—must be extracted before operation
14. Marked anemia or delayed clotting time
15. Persistent thymus or acidosis

SHAWKEY, Charleston, W. Va. [AM. J. DIS. CHILD.]

COMPARATIVE BACTERIOLOGY OF THE EPIPHARYNX, THE NOSE AND THE TONSILS WITH ESPECIAL CONSIDERATION OF ACUTE INFECTIONS. E. WIRTH and THEA BRAUN, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **141**:317, 1936.

This report by Wirth and Braun is based on the bacteriologic examination of 786 specimens from 56 persons. In giving a summary of their observations the authors state that even during health the epipharynx usually contains numerous micro-organisms of the oral flora, particularly oral streptococci and gram-negative cocci of the group Micrococcus catarrhalis. Contrary opinions in the literature notwithstanding, the authors consider an exact identification of the micro-organisms and their classification into pathologic and nonpathologic forms absolutely necessary. They think that the presence of numerous pathologic micro-organisms (hemolytic streptococci, pneumococci and influenza bacilli) in the epipharynx indicates a local disease process. Former bacteriologic studies on the nose and the palatine tonsils have suggested the same. The authors have observed, also, that in the same person the epipharyngeal flora is not always the same as the nasal and the tonsillar flora, but that most persons have a rather constant flora in the different parts of the upper respiratory tract. However, in different persons the flora varies greatly. In acute infections, the epipharyngeal specimens yield almost pure cultures of the pathogenic organisms. The results of cultures of material from the epipharynx are generally more reliable than those of material from the nose and the tonsils. For the determination of the pathogenic micro-organism the authors recommend the simultaneous withdrawal of secretion from the nose and the epipharynx by means of a straight cotton holder. They found that even in acute tonsillitis the epipharynx and the nose are usually involved, and they think that this is the reason that gargling and tablets are ineffective. Simultaneous examination of specimens from the nose, the epipharynx and the tonsils indicates that in acute infections the tonsils have not the predominating significance as point of origin which has been ascribed to them. The pathogenic organisms, particularly the hemolytic streptococci, frequently remain on the mucous membranes of the respiratory tract for a time after the subsidence of the clinical signs of the infection. For this reason these patients should be kept away from other patients even for a while after the subsidence of fever. EDITOR'S ABSTRACT.

REMOVAL OF TONSILS BY SHORT WAVE COAGULATION. V. FRÜHWALD and L. H. STIEBÖCK, Wien. klin. Wchnschr. **50**:1038 (July 9) 1937.

Since 1931 Frühwald and Stieböck have experimented with electrocoagulation of tonsils. At first they employed diathermy, but during the last two years they have adopted treatment by short waves. Coagulation by diathermy was found to cause irritation and pain, even when cocaine was given, and in some cases there was a faradic reaction.

Short wave treatment has proved very successful. It is recommended especially when advanced age, disease of the heart or kidneys or a tendency toward hemorrhage makes operation dangerous. Also it is advantageous when the patient cannot conveniently leave work for hospitalization or when a surgical operation on the throat would cause scar tissue that might deplorably damage the voice, as in a singer.

The throat is anesthetized with a 20 per cent cocaine solution. The tongue is held back with a wooden spatula, and the electrode is applied to the tonsils in several places. The treatment takes only a few seconds and is much more effective than diathermy. The authors recommend treatment of one tonsil at a time, with an interval of a week between treatments, until the entire growth has been removed. The coagulation serves to close the blood vessels and thus prevents both bleeding and infection. The patient requires a soft diet. As a gargle, lukewarm marshmallow tea is recommended.

A. F. ABT, Chicago. [AM. J. DIS. CHILD.]

HEMATURIA AFTER TONSILLECTOMY AND ADENOTOMY. HELMER RASMUSSEN, Hospitalstid. **80**:191 (Feb. 16) 1937.

Rasmussen says that in 5 cases of 117 of tonsillectomy and adenotomy, hematuria was found, and in 1 case, albuminuria. In all cases the conditions were slight and transitory. Slight transient hematuria was seen once after operation on the maxillary sinus. None of the patients had renal infection. The author considers it likely that in tonsillectomy and other operations toxins or small emboli enter the blood stream and settle in the glomeruli, causing either a slight injury which allows the erythrocytes to pass or a transitory focal glomerulonephritis.

HEKTOEN, Westby, Wis.

Miscellaneous

TREATMENT OF HEMOLYTIC STREPTOCOCCIC MENINGITIS WITH PARA-AMINO-BENZENE-SULFONAMIDE: REPORT OF A CASE WITH RECOVERY. J. G. ARNOLD, Ann. Int. Med. **10**:1198 (Feb.) 1937.

The patient was a white woman aged 28. A complete history of her case, with details of the treatment, are included in the report.

Twenty cubic centimeters of an 0.8 per cent solution of sulfanilamide (para-aminobenzenesulfonamide) in physiologic solution of sodium chloride was injected intraspinally. This dose was given at intervals until four successive cultures of spinal fluid were negative. In addition, this substance was given orally in the form of tablets for eleven days after the last positive culture of spinal fluid.

The drug is considered to be relatively nontoxic. Sulfhemoglobinemia and acidosis may occasionally be encountered after its use.

READING, Galveston, Texas. [AM. J. DIS. CHILD.]

THREE HUNDRED MIXED TUMORS OF THE SALIVARY GLANDS, OF WHICH SIXTY-NINE RECURRED. JOSEPH MCFARLAND, Surg., Gynec. & Obst. **63**:457, 1936.

This is the fourth of an unnumbered series of studies on tumors of the salivary glands extending over a period of ten years, each study embracing a larger series of tumors than its predecessors. So far as possible the patients from whom the

growths were removed were followed over a period of years in an effort to determine the outcome in each case. Slightly more than 23 per cent of the neoplasms recurred, and 13 per cent proved fatal. After long study, McFarland is convinced that attempts to correlate the histologic structure of mixed tumors of the salivary glands with their clinical behavior have totally failed and that microscopic examination as an aid to prognosis is of no value. Recurrence may take place at any time between the excision of the tumor and the end of a period of forty-seven years; thus it is impossible to prove that any tumor of this type will not have a recurrence. Available data indicate that roentgen ray and radium therapy are not more efficacious than surgical intervention. The importance of postponing operation until the tumors are "ripe," i. e., about the size of a lemon, is emphasized by convincing figures. As a rule, it may be said that the smaller the extirpated growth the greater is the probability of its recurrence.

HUNTER, Portland, Ore. [ARCH. PATH.]

LUNG ABSCESS. JAMES MAXWELL, Lancet **2**:413 (Aug. 22) 1936.

Maxwell defines "lung abscess" as "non-tuberculous suppuration with cavitation occurring in the lung tissue." The procedures and conditions which are most commonly associated with pulmonary suppuration appear to be operations in the mouth, pneumonia, a foreign body in a bronchus, bronchial carcinoma and certain abdominal operations. According to some, in the majority of cases the condition results from aspiration of infected material into the bronchial tree; others hold that a septic embolus lodging in a branch of the pulmonary artery is a much more frequent cause. Maxwell holds that both theories may on occasion be correct but that in either case there is commonly some underlying pathologic condition of the lung which affords an opportunity for the commencement of the suppurative process. It is also possible that on occasion the infection reaches the lung by way of the lymphatics.

In the course of his discussion on the diagnosis Maxwell states that needling should be employed only under exceptional circumstances. He holds that in most cases procrastination is the wisest policy. Medical treatment should be tried for at least eight weeks.

Bronchoscopic suction has doubtful value as a routine procedure in the cases in which the condition is acute. The cases most suited for this treatment are the same as those in which there is benefit from postural drainage.

Artificial pneumothorax is limited to those cases in which there is a deep-seated abscess which is draining freely into a bronchus but which proves to be slow to heal.

The indications for operation are chiefly abscesses which are situated toward the periphery, which are chronic and in which satisfactory bronchial drainage cannot be established. LANGMANN, New York. [AM. J. DIS. CHILD.]

THE TREATMENT OF CLEFT-PALATE SPEECH. W. K. WARD, South African M. J. **11**:433 (June 26) 1937.

The two great difficulties which face most patients with cleft palate are (1) that of preventing nasal emission of breath, which results in the peculiarly unpleasant hollow intonation and the "fluffy" articulation of consonants which characterize the speech, and (2) that of approximating the velum to the back of the tongue sufficiently to produce the k and g sounds. Ward describes exercises to overcome these difficulties. GONCE, Madison, Wis. [AM. J. DIS. CHILD.]

SUBDURAL ABSCESS. B. KARBOWSKI, Monatschr. f. Ohrenh. **70**:970 (Aug.) 1937.

Karbowski points out that, strictly speaking, there is no subdural space. The internal surface of the dura covers the external layer of the arachnoid. The internal layer of the arachnoid separates the arachnoid space from the subarachnoid

space. The narrow space between the two layers of the arachnoid is designated by some as the subdural and by others as the intermeningeal space. The author prefers the term arachnoidal space. He reports cases of abscess in the arachnoid space which indicate that suppuration of the arachnoid space may develop in the course of suppurating inflammation of the frontal sinus, as well as of the ear. The infection of the arachnoid space may develop by continuation from the bone or by way of the blood stream and may be localized far away from the primary focus. The auditory disturbances that lead to complications in the arachnoid space are not necessarily severe, but even mild disorders of the ear may lead to abscess. The clinical course is frequently like that of cerebral abscess. The diagnosis is often made difficult by the simultaneous existence of suppurating leptomeningitis and septic symptoms. The treatment is exclusively surgical. It should not be overlooked that an abscess of the arachnoidal space may be far away from the primary focus.

EDITOR'S ABSTRACT.

LOCATION OF DIRECTION OF SOUND BY THE BLIND. M. BERNOVITS, Monatschr. f. Ohrenh. **70**:984 (Aug.) 1937.

Bernovits made tests on blind persons to determine their ability to locate sound. He found that if the head was fixed and the source of sound was at the level of the ear, the blind person was able to locate it correctly, provided it was exactly in front or behind or to the left or the right. The location was less exact when the source of sound was between these points. However, the errors were never as great as they occasionally are in normal persons whose eyes have been covered. The estimation of the distance of the source of sound was always surprisingly exact. When the patients were permitted to turn the head, the location of the source of sound was more exact; the slight deviations observed in the first tests disappeared. In general, the author gained the impression that blind persons with normal auditory organs have a better capacity for the location of the direction of sound than have normal persons.

EDITOR'S ABSTRACT.

Society Transactions

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY

GEORGE M. COATES, M.D., *President*

Forty-Third Annual Meeting, Atlantic City, N. J., June 3, 4 and 5, 1937

E. W. HAGENS, M.D., *Editor of Abstracts*

CLIMATE AND THE UPPER PART OF THE RESPIRATORY SYSTEM. DR. C. COULTER CHARLTON, Atlantic City, N. J.

The medical profession since the time of Hippocrates has been interested in the relation of climatic conditions to health. People are greatly influenced by climate in their ability to resist infections of the upper part of the respiratory system. The autonomic system plays a great role in one's life, and it behooves every one to give it consideration. Persons in Atlantic City working in laundries with a high temperatures and moist heat do not seem to contract atrophic rhinitis. The climatic environment seems to prevent it. After living for a few years in seashore air, persons who have the condition seem to improve. Acute infections of the upper part of the respiratory system are less frequent and less severe in this climate than in the large cities. According to the records of the local weather bureau on temperature, humidity, sunshine and wind velocity, Atlantic City, as compared with other localities, has a great deal to offer persons suffering from infections of the upper part of the respiratory tract.

DISCUSSION

DR. FRANK R. SPENCER, Boulder, Colo.: The actinic chemical, or ultraviolet, rays of the sun are the tanning rays. They also stimulate the blood-forming organs to produce more red cells, which means more hemoglobin. Most patients with prolonged infection of the respiratory tract, such as sinus disease, have secondary anemia. Plenty of vitamins from fresh fruits and vegetables help to accomplish the same result. Patients with atrophic rhinitis do not do well in a high, dry, mountain climate. The moisture at the seashore is much better for them. The most important thing about climate is that a change often proves beneficial. Patients living at or near the sea level should take trips to the mountains, and vice versa.

DR. H. MARSHAL TAYLOR, Jacksonville, Fla.: It is difficult to separate climate from other environmental factors. Calcium, vitamin D and sunshine are important. One becomes more readily chilled in cold moist air than in cold dry air. Prolonged ischemia of the mucous membrane due to exposure of the body to cold reduces local resistance and favors infection.

DR. FRANCIS B. BLACKMAR, Columbus, Ga.: The adrenal glands of cows from the coastal plains near Savannah, Ga., are at least twice as large as those of cows from the seacoast. This is of interest in connection with atrophic rhinitis. Some patients with hay fever suffer in Miami, Fla., but are relieved in Birmingham, Ala. The probable explanation is that the seacoast, where the salty air contains sodium chloride in excess, is good for most allergic persons, but that there is a particular hypersensitiveness in some such persons.

DR. D. C. JARVIS, Barre, Vt.: If one cares to read the work of Peterson, of Chicago, and that of Mills, one cannot help realizing that the human body is influenced by climate. Twenty-four of the twenty-six storm tracks that sweep

across the United States make their exit over Vermont to the Atlantic Ocean. During the winter months there is a great deal of disease of the respiratory tract in Vermont. A change in environment is often a change in intake of food, and in this way is beneficial. The mineral content of the drinking water is another important factor.

DR. BURT R. SHURLY, Detroit: I think that the overheating of houses really explains why there is so much infection in northern cities. Tuberculous patients who are sent to New Mexico do remarkably well. The open air schools in Detroit have proved of great value.

DR. E. LE ROY, Newark, N. J.: Experience has shown that an even, warm climate with a high humidity allows the nasal membrane to remain in a state of physiologic rest, which answers the question of why such a climate is helpful.

DR. EUGENE R. LEWIS, Los Angeles: One speaks of the effect of the different climates on patients as if patients were all exactly the same; but they are not. There is a great difference between those who do well and those who do not do well when the climate is the same.

DYSPHEMIA AND DYSPHONIA. DR. JAMES SONNETT GREENE, New York.

This paper was published in full in a previous issue of the ARCHIVES (**26**:74 [July] 1937).

DISCUSSION

DR. SAMUEL J. KOPETZKY, New York: The paper stresses the important point that the patient should be studied physically, physiologically and neurologically and that treatment along such lines plays a large role. Is it true that a left-handed person who as a child is changed to a right-handed one may later in life become a stutterer?

DR. JAMES E. MCASKILL, Watertown, N. Y.: I have been a patient of Dr. Greene's, and his clinic proved to be one of the most interesting and inspiring of places. To the badly handicapped people there a new world has been opened up. A problem in public health is involved in the conditions under discussion, and surely a speech defect is just as worthy of attention as impaired hearing or defective vision.

DR. JAMES SONNETT GREENE, New York: In reference to left-handedness and right-handedness, the whole subject has been overemphasized. It is a neurologic problem; the stutterer is arrhythmic and lacks coordination of the processes involved in speech.

ETIOLOGY, PROPHYLAXIS AND TREATMENT OF SURGICAL SEPTICEMIA. DR. JOHN A. KOLMER, Philadelphia (by invitation).

This paper was published in full in a previous issue of the ARCHIVES (**26**:59 [July] 1937).

DISCUSSION

DR. ELBYRNE G. GILL, Roanoke, Va.: The most effective medical treatment for combating infection of the blood stream may be listed as follows: (1) transfusion of immunized blood, (2) transfusions of immune human serum, (3) administration of antistreptococcus serum, (4) intravenous injection of dextrose and saline solution, (5) the use of sulfanilamide, (6) nonspecific protein therapy and (7) bacteriophage. Notes were given on 4 cases in which surgical treatment and transfusions of immunized blood were employed.

DR. GEORGE M. COATES, Philadelphia: One should always bear in mind that the blood has a great capacity for clearing itself of bacteria. Every method should be utilized to heighten the powers of immunity, both local and general. Surgical intervention should be properly timed and thorough; yet it should be carried out with gentleness, and no time should be wasted. Sulfanilamide tablets have proved satisfactory in the treatment of streptococcic septicemia.

Dr. Ernest M. Seydell, Wichita, Kan.: Vincent, of Brussels, has perfected a polyvalent serum which has been widely acclaimed in Belguim and in France. He states that it is antitoxic and bactericidal. It is prepared by inoculation of horses with virulent strains of streptococci and their toxins. Large doses of sodium salicylate are said to prevent serum sickness. In 1935 he reported that in 310 cases in which the disease was verified by cultures, 81.3 per cent of the patients were cured and 18.7 per cent of the attacks were fatal.

Dr. John A. Kolmer, Philadelphia: I am glad to hear these figures quoted because I think they lend support to the early administration of antistreptococcus serum. Vincent's success is probably due to his using large amounts of the serum.

Some Observations on the Management of Infections of the Blood Stream from Mastoiditis. Dr. Ralph A. Fenton, Portland, Ore.

This paper was published in full in a previous issue of the Archives (**25**:618 [June] 1937).

DISCUSSION

Dr. Ernest M. Seydell, Wichita, Kan.: Rather frequently one sees a generalized otogenous infection without sinus thrombosis. There may be a direct extension of the infection into the veins of the middle ear; mastoiditis or phlebitis of the sinus may exist without thrombosis, or, finally, there may be osteophlebitis of the smaller veins in the mastoid, which by extension into a sinus or by the formation of emboli may produce a generalized infection. Since it is not always possible to differentiate sepsis resulting from sinus thrombosis from sepsis of hematogenous origin, and since ligation of the jugular vein or opening of the lateral sinus is not necessary in the treatment of hematogenous sepsis, I have made it a rule never to perform a primary ligation of the jugular vein. Furthermore, I do not always puncture or incise the sigmoid sinus. These procedures are carried out only when definite indications are present.

Dr. H. I. Lillie, Rochester, Minn.: Blood transfusions are to be used as supportive treatment for well directed surgical measures. It is as erroneous to say that the sigmoid sinus and the jugular vein should always be dealt with surgically as it is to say that they should never be subjected to surgical intervention. In the treatment of hemorrhagic mastoiditis it is always important to keep track of an apparently healed scar. When sepsis is present from the onset, hemorrhagic mastoiditis may be suspected and early operation advised. If signs of sepsis appear suddenly in the course of an ordinary convalescence in a patient with hemorrhagic mastoiditis, sinus phlebitis may be suspected. In patients with coalescent mastoiditis, signs of infection of the blood stream usually appear suddenly later in the course or develop more gradually from the onset as a result of thrombosis of the sinus.

Dr. Lyman G. Richards, Boston: I should like to raise the question of what may be termed early operation. In general, operation on the mastoid within the first day or two has proved to be a mistake and provocative of the very complications which one is trying to avoid. I am not yet convinced that hematogenous infection of the mastoid is not a forerunner, an earlier stage, of the coalescent type of infection.

Dr. Joseph C. Beck, Chicago: Dr. Richards is mistaken in regard to the histologic change in the thrombotic type of mastoiditis. The change cannot be dealt with on the basis of time; it must be dealt with on the basis of the virulence of the organism.

Dr. Thomas C. Galloway, Evanston, Ill.: I am absolutely convinced of the great value of sulfanilamide. The Cook County Hospital has a blood bank, where blood is preserved for about six weeks at 40 C.

Dr. David R. Higbee, San Diego, Calif.: I am certain that I have gotten into trouble as frequently by waiting for a mastoid infection to be walled off as I have from operating too early. Nothing is to be gained from a roentgen study

of hemorrhagic mastoiditis. It seems to me that whenever a patient with a mastoid infection is not doing well it is time to operate.

DR. ELBYRNE G. GILL, Roanoke, Va.: I give dextrose and saline solution by the continuous drip method. I think blood transfusion should be considered not only as a supportive measure but as a bactericidal aid as well. Blood from immunized donors is important.

DR. SAMUEL J. KOPETZKY, New York: Hemorrhagic mastoiditis does not merge into the coalescent type. If there is any merging, it is to form small sequestrums. Another point is that the patient does very well if his diet contains plenty of beef.

DR. RALPH A. FENTON, Portland, Ore.: I agree with Dr. Beck and Dr. Kopetzky respecting the pathologic changes in hemorrhagic mastoiditis.

MYXOMA OF THE PALATE AND PHARYNX. DR. JAMES A. BABBITT and DR. DAMON B. PFEIFFER, Philadelphia.

This paper was published in full in a previous issue of the ARCHIVES (**26**:453 [Oct.] 1937).

DISCUSSION

DR. EDWARD H. CAMPBELL, Philadelphia: Any tumor of such a size and location is rare and should make a report of interest from the standpoint of diagnosis and of operative technic. The surgical procedure used in this case could hardly have been improved. The patient should be kept under observation for possible recurrence.

DR. ARTHUR W. PROETZ, St. Louis: The similarity of this tumor to a nasal polyp makes one wonder whether it may not have had an inflammatory origin. A chance inflammatory reaction to some embryonic rest may give rise to such a growth.

DR. JAMES A. BABBITT, Philadelphia: I am much interested in Dr. Proetz's suggestion.

SURGICAL TREATMENT FOR SUPPURATIVE PETROSITIS. DR. SAMUEL J. KOPETZKY, New York.

This paper was published in full in a previous issue of the ARCHIVES (**26**:294 [Sept.] 1937).

DISCUSSION

DR. H. I. LILLIE, Rochester, Minn.: Kopetzky has given a fair, logical and comprehensive critique of the rationale of the surgical treatment of suppurative lesions of the petrous pyramid. It seems apparent that in such treatment the location of the lesion is of first importance and that the surgical procedure necessary for adequate treatment will automatically suggest itself.

DR. JOHN RANDOLPH PAGE, New York: I am of the opinion that too much attention has been called to the exceptional cases and that not enough emphasis has been placed on the efficacy of conservative measures in the large majority of cases. I am sure that in many cases what seems to be secondary mastoiditis, simply requiring reoperation, might be classed as petrositis. This may be why some services report so many cases while others have few or none.

DR. WELLS P. EAGLETON, Newark, N. J.: I wish to recall the concepts that I have contributed relative to surgical treatment of suppuration of the apex. I believe that 80 per cent of the patients with petrosal infection get well because of the inherent nature of the red marrow of the bone; in 18 per cent a localized empyema forms and if the infection is properly treated it is curable, and 5 per cent have invasive types of thrombophlebitis of the small vessels, which today cannot be cured because of the nature of the lesion.

DR. JOHN F. BARNHILL, Miami Beach, Fla.: Having gone over several hundred petrous tips on cadavers, I disagree with Dr. Eagleton about the petrous tip.

Also, if the mastoid cells are extensively developed the operator should be unusually thorough, as there is likely to be considerable pneumatization of the petrosa.

Dr. Samuel J. Kopetzky, New York: All the cases reviewed were scrupulously separated from those of secondary infection.

Nasopharyngeal Abscesses and Cysts. Dr. Fletcher D. Woodward, University, Va.

This paper was published in full in a previous issue of the Archives (**26**:38 [July] 1937).

DISCUSSION

Dr. Karl M. Houser, Philadelphia: My feeling is that microscopic study will show a larger number of such abscesses to be inflammatory retention cysts of lymphoid tissue than is at present suspected.

Dr. Joseph C. Beck, Chicago: A useful diagnostic procedure is to fill the cyst with iodized poppy seed oil. To draw the palate forward, with two soft catheters inserted through the nose, gives a much wider view of the lesion.

Dr. Austin A. Hayden, Chicago: I feel that examination of the nasopharynx with the finger is absolutely contraindicated.

Hearing Before and After Radical Mastoidectomy. Dr. Edmund Prince Fowler, New York.

This paper was published in full in a previous issue of the Archives (**26**:387 [Oct.] 1937).

DISCUSSION

Dr. Austin A. Hayden, Chicago: Dr. Fowler shows that, as a rule, what has been said for a long time is true; i. e., hearing, with few exceptions, is not improved by a radical mastoid operation.

Dr. Gordon Berry, Worcester, Mass.: It is of interest that cases in which skin grafting is used show no gain over those in which it is not used. Dr. Fowler does not like the term "modified radical mastoidectomy." His plea for conservation of hearing urges me to try some modification of the extremely radical technic in certain cases.

Dr. Eugene R. Lewis, Los Angeles, Calif.: One's attention is far too often concentrated on the attainment of a dry ear. I think the direction of main interest should be shifted and that it should be determined how the ear is serving the patient, even though it is discharging. Too much stress has been laid on the danger of failing to clean out thoroughly every particle of pus when one is operating for the relief of mastoiditis.

Dr. George W. MacKenzie, Philadelphia: When a patient's ear becomes stopped up with discharge, the condition certainly needs attention. The hearing may be poor after operation because the operator was careless in the use of the curet in a posterior median direction. Again, lack of proper after-treatment may allow excessive granulations to become organized. Latent tuberculosis or syphilis have been the cause of reduced hearing in some cases.

Dr. David R. Higbee, San Diego, Calif.: It has occurred to me that in disease of the middle ear the conductive mechanism itself may be acting as an obstruction to the sound waves. I think that a 5 decibel increase in relation to what is called subjective response is of enormous benefit to the patient.

Dr. Arthur C. Jones, Boise, Idaho: My son has had considerable ear infection, and now, after bilateral complete mastoidectomy for acute bilateral mastoiditis, he hears the whispered voice at 30 feet, whereas several years ago his hearing was only 50 per cent.

Dr. Edmund Prince Fowler, New York: I do not agree with Dr. Lewis about looking for the last cell in the mastoid. Many diseased ears afford better hearing when they contain moisture. When they heal up, the patient does not hear as well as before. However, that is not an excuse for not stopping a suppuration which is a threat to health and life. I do not operate on a patient who has good hearing unless his life is threatened. Most of the patients had very poor hearing before operation.

Irradiation for Infection in Otolaryngology. Dr. Thomas C. Galloway, Evanston, Ill.

This paper was published in full in a previous issue of the Archives (**26**:377 [Sept.] 1937).

DISCUSSION

Dr. W. E. Grove, Milwaukee: Irradiation is efficacious in its own right and also as an adjunct to surgical intervention in the treatment of certain infections about the face, head and neck. I have found it helpful in treating many conditions. The infected field is rapidly sterilized, but just how this occurs is not entirely clear.

Dr. Howard C. Ballenger, Chicago: Roentgen treatment seems to have proved of value in the treatment of erysipelas, furunculosis, carbuncles and some forms of cellulitis. I have refrained from using it in cases of deep infection of the neck, especially if the breathing is partly obstructed.

Dr. Matthew S. Ersner, Philadelphia: Mesodermal tissue is radiosensitive, and that is why glands and vascular tissues or growths of such tissue respond to roentgen treatment. I have been using it carefully in cases of chronic suppurative otitis media.

Dr. Edmund Prince Fowler, New York: I think control cases should be presented in connection with all clinical subjects.

Dr. Thomas C. Galloway, Evanston, Ill.: It is certain that the worst results come from overtreatment, and the better authorities are all working toward the use of the smaller doses.

Unrecognized Complications Secondary to Peritonsillar and Lateral Pharyngeal Abscess. Dr. Charles T. Porter, Boston.

This paper was published in full in a previous issue of the Archives (**26**:127 [Aug.] 1937).

DISCUSSION

Dr. Harris P. Mosher, Boston: These 3 cases have been well reported. Too many patients are inadequately operated on and too many operations too long delayed. When in doubt regarding an infection of the neck, one should do an exploratory operation.

Dr. Fredrick T. Hill, Waterville, Maine: I have long felt that all peritonsillar infections should be considered as major conditions and that the patient should be hospitalized. The continuance of sepsis, the appearance of external swelling, the prolapse of the lateral pharyngeal wall and, especially, the presence of trismus are most significant signs and usually indicate the advisability of external approach.

Dr. Frank R. Spencer, Boulder, Colo.: I am in favor of the otolaryngologists doing more operations on the neck.

Dr. Edward King, Cincinnati, Ohio.: Three patients with severe hemorrhage have come under my care, and 2 of them have died. The general surgeons called in consultation had a horror of tying the carotid artery. Had it been tied these patients might have lived.

A Method for Maintaining Apposition of the Mucosal Flaps After Submucous Resection. Dr. Harold Leslie Kearney, New Orleans, La.

One of the most annoying complications following submucous resection of the nasal septum is hematoma. This condition occurs most often on the second day, after removal of the usual splint or pack employed to maintain contact of the septal flaps. A double suture of 00 plain catgut is accomplished by threading a hypodermic needle with the catgut and twice passing the needle obliquely through the septal flaps. Tying the ends of the sutures draws the flaps firmly together.

DISCUSSION

Dr. James A. Babbitt, Philadelphia: I think this is a fine suggestion and I am going to use it.

Dr. Fredrick T. Hill, Waterville, Maine: Twenty years ago Dr. Lothrop used this method, although he used a right angle needle instead of a hypodermic needle.

Characteristics of Modern Electrically Operated Audiometers. Dr. Matthew S. Ersner, Leon Podolsky, E. E. (by invitation) and Dr. David Myers (by invitation), Philadelphia.

This paper was published in full in a recent issue of the Archives (**26**:400 [Oct.] 1937).

DISCUSSION

Dr. Horace Newhart, Minneapolis: During the past years two committees, the Subcommittee on Audiometry and Hearing Aids of the Sectional Committee on Acoustical Measurements and Terminology of the American Standards Association and the Committee appointed by the Council on Physical Therapy of the American Medical Association, have labored to produce minimum specifications for the construction and performance of audiometers for diagnostic purposes. The reports, I am happy to say, are nearly completed. I am often asked which audiometer I would recommend. This is perhaps because for some years I have been doing a small amount of research work on the characteristic output of these instruments. Because of my position on one of the aforementioned committees, I have felt up to the present time that, to avoid embarrassment and confusion, it was necessary not to recommend any one instrument, but to urge postponement. This is unfair, I feel, to the manufacturers, and the sooner the proposed plan is put into effect for depending on the American Medical Association or some equally authoritative group to recommend officially or accept suitable audiometers the better the situation will be.

Dr. Edmund Prince Fowler, New York: No matter how perfect an audiometer is when it reaches the otologist, it will have to be calibrated from time to time. The receivers often fall and are more at fault than the audiometer. I would urge every one not to buy any audiometer that does not come up to the standards which will be promulgated by the Council on Physical Therapy of the American Medical Association. In taking audiometric records masking the opposite ear is important.

Dr. Austin A. Hayden, Chicago: I think the need for standardization of audiometers is acute. Standardization should be kept in the hands of otologists. If performed with a little care the tests should be as infallible as any test can be.

Mr. Leon Podolsky, Philadelphia: In my opinion the standards for audiometers should be written on a scientific basis and audiometers made to fit the standard. The air pressure method of masking suggested by Dr. Fowler is excellent.

Small Doses of Insulin in Otolaryngology. Dr. D. C. Jarvis, Barre, Vt.

This paper was published in full in a previous issue of the Archives (**26**:66 [July] 1937).

DISCUSSION

Dr. J. W. Jervey, Greenville, S. C.: It seems to me that Dr. Jarvis's paper presents about the most significant subject that has been brought to the attention of this society for a long time. It is being recognized that physiologic function is the root, rock and foundation of pathologic control. Insulin is of considerable value in the treatment of a number of conditions: rhinitis, laryngitis, early mastoiditis, tubal congestion and catarrhal otitis media.

Dr. F. B. Blackmar, Columbus, Ga.: I have been using insulin in the treatment of more chronic conditions. I have had an opportunity to satisfy myself that its worth is fully as great as Dr. Jarvis has said. A group of symptoms which respond regularly to the administration of insulin consists of vertigo, tinnitus, nerve deafness, tingling of the extremities when the patient is at rest and contraction of the fields of vision for red. Edema and pain from pressure on nerves may be rapidly benefited by the administration of insulin. Beware of its use in cases of meningitis, as the sugar content of the cerebrospinal fluid is already low and a single unit of insulin will cause the distressing tremors and spasms of hypoglycemia.

Dr. Eugene R. Lewis, Los Angeles, Calif.: The otolaryngologist calls himself a doctor of medicine, but he is essentially a chemophysicist.

Dr. Don M. Campbell, Detroit: In the past several conditions have not been sufficiently considered: avitaminosis, endocrinology and allergy.

Dr. Burt R. Shurly, Detroit: In order to inspire a belief that hydrochloric acid in 5 drop doses, insulin in 3 unit doses and iodine in 1 drop doses produce these marvelous results, more cases will be necessary.

Dr. Thomas E. Carmody, Denver: I have had good results with these remedies, but one must not forget the good results the old tonics containing iron, quinine and strychnine have given.

Dr. Edmund Prince Fowler, New York: One must be careful to make accurate observations before, during and after all these experimental procedures, and one must have controls.

Dr. Austin A. Hayden, Chicago: Nothing has been said about the estimation of the blood sugar content, which seems necessary to me.

Dr. Matthew S. Ersner, Philadelphia: My results with insulin have been gratifying in cases of mastoiditis in which there was poor postoperative healing.

A Case of Gangrenous Osteomyelitis of the Paranasal Sinuses. Dr. Alfred Lewy, Chicago.

This paper was published in full in a previous issue of the Archives (**27**:91 [Jan.] 1938).

DISCUSSION

Dr. Fredrick T. Hill, Waterville, Maine: From a practical point of view, it seems to me that this patient's condition became hopeless in the first month of her illness, before she came under Dr. Lewy's care. Just as in any case of osteomyelitis, unless the condition remains self limited, early and thorough removal of the infected area offers the best prognosis, and all considerations of the cosmetic result must be waived. Any one who has the care of a patient presenting such insurmountable difficulties is deserving of sympathy, and it is cause for congratulation that such cases are as rare as they are.

Dr. Joseph C. Beck, Chicago: I had the privilege of seeing this patient on two occasions when she was in the Illinois Eye and Ear Infirmary, and persons who are acquainted with Dr. Lewy's acumen for therapeutics and desire to try the rational things in the treatment of any disease can surely appreciate his effort to control the spread of the disease. Any physician who has seen ulcerative conditions around the face would say the infection was syphilitic, and that was my belief. It might be a gumma, multiple osteosis and a destructive process. The

operation had nothing to do with it, since it was not a starting point for osteomyelitis of the superior maxilla, which presents an entirely different picture, and one would have to think of a fungous infection and noma.

Dr. John J. Shea, Memphis, Tenn.: I had a similar case this past year, and it had a legal aspect; similar cases should be reported in the literature.

Dr. Gordon B. New, Rochester, Minn.: Dr. Lewy stated that blastomycosis was found but that treatment was not followed through.

Dr. Alfred Lewy, Chicago: Several blastomycosis organisms were found, but a diagnosis could not be made. My own suspicion was that some sort of fungous infection was there, but repeated examination failed to prove it.

Book Reviews

Cutaneous Cancer and Precancer: A Practical Monograph. By GEORGE M. MACKEE, M.D., and ANTHONY C. CIPOLLARO, M.D. New York: American Journal of Cancer, 1937.

This small volume has been written primarily for the general practitioner and the dermatologist. It stresses the clinical picture of the cancerous lesion as it presents itself.

It is especially valuable in that it offers many useful clinical points, derived from the rich experience and accurate observation of the author and of his co-workers, which are not ordinarily found in more pretentious volumes.

This monograph, because of its profuse illustration and accurate descriptions, will assist the beginner in the practice of medicine to recognize a precancerous lesion, thus making possible early and proper treatment.

News and Comment

THE AMERICAN BOARD OF OTOLARYNGOLOGY

An examination was held in Chicago, Oct. 8 and 9, 1937. One hundred and one candidates were examined, of which number 79 were certified.

An examination will be held in San Francisco, June 10 and 11, 1938, prior to the meeting of the American Medical Association. Application blanks may be secured from the secretary, Dr. W. P. Wherry, 1500 Medical Arts Building, Omaha.

Directory of Otolaryngologic Societies *

FOREIGN

COLLEGIUM OTO-RHINO-LARYNGOLOGICUM AMICITIÆ SACRUM

President: Prof. H. Burger, Keizersgracht 317 C, Amsterdam.
Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg 143, Groningen, Netherlands.

SOCIEDAD RIOPLATENSE DE OTO-RINO-LARINGOLOGÍA (ARGENTINE SECTION)

President: Dr. Raul Becco, B. Mitre 1690, Buenos Aires, Argentina.
Secretary: Dr. Juan Manuel Tato, Santa Fé 1171, Buenos Aires, Argentina.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON LARYNGOLOGY, OTOLOGY AND RHINOLOGY

Chairman: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
Secretary: Dr. Leroy A. Schall, 270 Commonwealth Ave., Boston.
Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN BRONCHOSCOPIC SOCIETY

President: Dr. Gordon Berry, 36 Pleasant St., Worcester, Mass.
Secretary: Dr. Lyman Richards, 319 Longwood Ave., Boston.
Place: Atlantic City, N. J. Time: April 30, 1938.

AMERICAN LARYNGOLOGICAL ASSOCIATION

President: Dr. J. F. Barnhill, Miami Beach, Fla.
Secretary: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Place: Atlantic City, N. J. Time: May 2-4, 1938.

AMERICAN LARYNGOLOGICAL, RHINOLOGICAL AND OTOLOGICAL SOCIETY, INC.

President: Dr. Samuel J. Kopetzky, 71 E. 80th St., New York.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Place: Atlantic City, N. J. Time: April 27-29, 1938.

SECTIONS:

Eastern.—Chairman: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia.
Place: Philadelphia. Time: Jan. 7, 1938.
Southern.—Chairman: Dr. Murdock S. Equen, Medical Arts Bldg., Atlanta, Ga.
Place: Atlanta, Ga. Time: Jan. 24, 1938.
Middle.—Chairman: Dr. James B. Costen, Beaumont Bldg., St. Louis.
Place: St. Louis, Mo. Time: Jan. 26, 1938.
Western.—Chairman: Dr. Arthur C. Jones, 105 N. 8th St., Boise, Idaho.
Place: Santa Barbara, Calif. Time: Jan. 30-31, 1938.

AMERICAN OTOLOGICAL SOCIETY

President: Dr. Harris P. Mosher, 828 Beacon St., Boston.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.
Place: Atlantic City, N. J. Time: May 5-6, 1938.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.